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ANNALS

of the Association of American Geographers

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Volume 51 • Number 4
December 1961

CONTENTS

The Task Ahead ____ C. W. Thornthwaite
The Oregon Trail and Union Pacific Railroad: A Contrast in Purpose, James E. Vance, Jr.
Growth of Individual Metropolitan Areas: A Global View ____ Jack P. Gibbs
Homer Leroy Shantz, 1876–1958 ____ Evelyn L. Pruitt
Harlan H. Barrows, 1877–1960 ____ Charles C. Colby and Gilbert F. White
Letter to the Editor ____ Pierre Gourou
Abstracts of Papers Presented at the 57th Annual Meeting of the Association of American Geographers, East Lansing, Michigan, August 28–September 1, 1961

ANNALS of the Association of American Geographers is published quarterly in March, June, September, and December at the Allen Press, Lawrence, Kansas

Subscription rate: $10.00 per calendar year
Volumes 48 and later: $10.00 per volume; $2.50 per issue
Volumes 42–47 incl.: $5.00 per volume; $1.25 per issue
Volume 41: $4.00 per volume; $1.00 per issue

Address all communications relative to subscriptions, purchase of back numbers, etc., to Association of American Geographers, 1785 Massachusetts Ave., N.W., Washington 6, D.C.

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ANNALS of the
Association of American Geographers

Volume 51 December 1961 Number 4

THE TASK AHEAD[1]

C. W. THORNTHWAITE

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IN making preparation for the task that is mine this evening I have spent several days reading the *Annals* of the Association of American Geographers. My object was to learn what other speakers have said on similar occasions, and to get an indication of what the geographers of my generation have been doing. During that search I also made the acquaintance of several books and monographs that were new to me, and I studied the offerings of Geography Departments throughout the country. This has been a revealing experience because I found that there is wide diversity as to the content and method of geography. With some few exceptions, however, the curriculum has become quite standardized everywhere.

OPPOSING CONCEPTS IN GEOGRAPHY

It has been widely accepted that geography deals with the areal or regional differentiation of the earth. As many as twenty-five different regional courses are offered in some Geography Departments, and it would appear that a majority of the academic geographers are busy doing regional studies, writing regional textbooks, and directing regional doctoral dissertations. This development in the colleges and universities has strongly conditioned the training of students who aspire to become geographers.

Some scholars have taken vigorous exception to what is called the regional concept in geography. It seems to me that this opposing view has been expressed most clearly and convincingly in the *Annals* in three essays by Leighly[2] and in one by Ackerman.[3] Leighly's original dissent came early, at a time when few could see the direction that geography was taking. He recognized that the compilation of information about the various parts of the earth, making it readily accessible as in an encyclopedia, which comprises the writing of regional textbooks or regional studies, was a useful service. He did not agree, however, that the performance of this service could encompass the whole field of geography, if indeed it was geography; nor did he agree that the professional geographer could perform the service as well as professional compilers. In summing up he said:

> Systematic regional description has its uses, uses similar to those of lexicography. Like lexicography, it has its own problems and its own techniques for solving them. It seems to me, however, that it can scarcely become a program for any considerable body of scholars, nor reasonably claim a place in the academic world. Facts about the old settled parts of the earth that go into systematic regional descriptions do not come at first-hand from a single class of investigators, but from a whole wide range of sources . . .[4]

In a classic attack on the shift toward regionalism, Leighly in 1955 urged the revival of physical geography. Using a definition from

[1] Address given by the Honorary President of the Association of American Geographers at its 57th Annual Meeting, East Lansing, Michigan, August 31, 1961.

[2] John Leighly, "Some Comments on Contemporary Geographic Method," *Annals*, Association of American Geographers, Vol. 27 (1937), pp. 125–141; *idem*, "Methodologic Controversy in Nineteenth Century German Geography," *ibid.*, Vol. 28 (1938), pp. 238–258; and *idem*, "What Has Happened to Physical Geography?" *ibid.*, Vol. 45 (1955), pp. 310–318.

[3] Edward A. Ackerman, "Geographic Training, Wartime Research, and Immediate Professional Objectives," *Annals*, Association of American Geographers, Vol. 35 (1945), pp. 121–143.

[4] *Op. cit.*, p. 140.

Russell Hinman's textbook of 1888 which says that "Physical geography seeks to trace the operation of the laws of nature upon the earth; upon the air, the water, and the land; upon plants, animals, and even upon man,"[5] he points out that the earth must be approached from the viewpoint of the physical and natural sciences, and studied in its own terms and for its own sake. He charged that geographers do not receive the required rigorous training in physical science and mathematics to work competently in physical geography. Leighly ended with a call to action. "Let us resume the fresh and frank quest that Hinman announced . . . 'to trace the operation of the laws of nature upon the earth.' The land, the sky, and the water confront us with questions wherever we look at them with open eyes. These questions, and the privilege of sharing in the quest of answers to them, are a part of our birthright."[6]

Leighly's argument supports the conclusion that regional description, as it has been developed by academic geographers, is mere compilation, where the skills required are in writing and in library search, but that this does not provide the proper training for geographic research and can add nothing to our store of knowledge about the earth. Only those who have mastered geomorphology, climatology, hydrology, soil geography, economic geography, transportation geography, population geography, cultural geography, and so on, can do that. I might add that this mastery greatly enhances any regional study, by assuring that it will deal with the truly significant phenomena in the region. Perhaps the best regional study ever to appear in the *Annals* was done nearly 40 years ago and consisted of four essays on the Great Plains by Marbut, Kincer, Shantz, and Baker,[7] who were all members of the Association but none in academic pursuits.

Ackerman's essay dealt with the lessons learned during the war. He pointed out the deficiencies of the regional method and of geographic training as revealed by wartime service, but made it clear that the handicaps carry over into peacetime as well. He said:

> . . . The regional method of research . . . proved to have [little] value . . . Where anything more than superficial analysis was required . . . the only possible course was one of systematic specialization. Dependable accumulations of data, and reliable interpretations of those data were not to be had otherwise . . . Just being a geographer, even though originally it led to employment, was not enough when it came to performance . . . After the first frantic burst of effort very few responsible persons considered the pure regional geographer a specialist —even the best and most experienced among them. The superficiality of the "regionally" trained geographer's information . . . was readily evident . . . This view would suggest . . . that in the future no student of a region who lacks a systematic specialty should be considered a geographic specialist, or even worthy of a higher degree. Detailed systematic studies would then be considered a basic, inescapable phase of our training and research . . .[8]

I should like to underscore Ackerman's warning that "human geography will never be accepted as a mature scholarly discipline until a more thorough systematic literature begins to take shape in it."[9] A commentary on his thesis describes the regional approach as trying "to put boundaries that do not exist around areas that do not matter"[10] and "laborious transferring of dead bones from one coffin to another."[11] In another recent essay Ackerman made the following summary; "Thus the impression arose that the compilation of any set of data in a geographical binding and with a certain seasoning of correlation constituted research in human geography."[12]

Ackerman's essay is long and I cannot take the time to quote more of it, but I commend it to you. It is now sixteen years old but still very timely and I suspect that only a few of our present members are acquainted with it.

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[5] Russell Hinman, *Eclectic Physical Geography* (New York, 1888), p. 2.

[6] *Op. cit.*, p. 318.

[7] C. F. Marbut, "Soils of the Great Plains," *Annals*, Association of American Geographers, Vol. 13 (1923), pp. 41–66; Joseph B. Kincer, "The Climate of the Great Plains as a Factor in Their Utilization," *ibid.*, Vol. 13 (1923), pp. 67–80; H. L. Shantz, "The Natural Vegetation of the Great Plains Region," *ibid.*, Vol. 13 (1923), pp. 81–107; O. E. Baker, "The Agriculture of the Great Plains Region," *ibid.*, Vol. 13 (1923), pp. 109–167.

[8] Ackerman, *op. cit.*, pp. 128, 129.

[9] *Ibid.*, p. 141.

[10] George H. T. Kimble, "The Inadequacy of the Regional Concept," in *London Essays in Geography*, L. Dudley Stamp and S. W. Wooldridge, eds. (London, 1951), p. 159; see also Wilbur Zelinsky's review in *Annals*, Association of American Geographers, Vol. 41 (1951), p. 266.

[11] Kimble, *op. cit.*, p. 174.

[12] Edward A. Ackerman, *Geography as a Fundamental Research Discipline*, University of Chicago Department of Geography Research Paper No. 53 (Chicago, 1958), p. 8.

I would like to see it reprinted along with Leighly's three thoughtful essays, together with certain others that would be selected, to make them available to the new generation of geographers.

Early in 1961 the Association issued an official pamphlet on "Status and Trends of Geography in the United States 1957–1960."[13] Although it contains chapters on geographers in business and in government and elsewhere, the introductory statement says that geographers have only one task—to teach. First, they must teach undergraduates who need to know some geography but have no wish to become geographers, and second, they must train geographers to do this teaching. The author says that geography is a form of general education like history, and both together provide the basic framework of place and period essential for understanding the social, political, and economic problems of the modern world. By way of amplification, however, he says: "in other words, the profession is called upon to develop regional specialists, and to offer courses in particular regions in academic institutions taught expertly by recognized specialists."[14]

But according to the pamphlet the profession does not really develop the regional specialist. He becomes a specialist only after a lifetime of study devoted to the many aspects of a particular area. The new holder of the doctorate entering into a teaching position in an academic institution may "possess competence in certain understandings of a topical field," and a "feeling for the role he is to play in continuing the traditions of his professional field," but not the "understandings" and "experiences" that would make him a regional specialist.[15] This view coincides with that of the Committee on Training and Standards which said in 1946, "Graduate training cannot hope, and therefore should not pretend, to produce regional specialists, but rather to train men so that they will have the ability and the incentive to become regional specialists later."[16]

It appears that the great majority of those who call themselves geographers are professors and teachers. They are therefore mainly concerned with the presentation of material to students. For the most part the title "geographer" means University professor, the center of activity of the geographer is the classroom, and a "regional specialist" is one who can organize and teach a regional course in a creditable fashion in a college classroom. The research that would thus be expected of the geographer consists of seeking out and assembling the course material from a variety of sources, organizing it according to some logical pattern, designing accompanying maps, and selecting relevant photographic illustrations. The skills involved are the ones that would enable him to carry out this program. They would include ability to write in acceptable English, read foreign language sources, and have some knowledge of maps.

That growing numbers of geographers entertain different views as to the content and objectives of geography and as to the training required for productive work in the field is attested by the increasing emphasis on quantitative methods. This new development has aroused a certain uneasiness among the regionalists and may have put them on the defensive. It is admitted that "the proponents of the modern methods of quantitative analysis have raised geographical study to a higher level of sophistication," but "the focus of geographical attention [remains] on the characteristics of particular places."[17] Almost sorrowfully, we are asked to consider the question: "Where is the current trend toward increasing quantification taking us?"[18]

Thus, arising at the side of Leighly, who charged that the physical problems of the earth are a part of the responsibility of geography, are the geographers who see that economic, social, and cultural problems can have a depth not to be reached by the so-called "standard" geographical techniques. I am sure that Leighly did not exclude those problems when he said, "The land, the sky, and the wa-

[13] *Status and Trends of Geography in the United States 1957–1960* (Association of American Geographers, 1961).

[14] *Ibid.*, p. 12.

[15] *Ibid.*, p. 13.

[16] Report of the Committee on Training and Standards in the Geographic Profession, National Research Council, "Lessons from the War-time Experience for Improving Graduate Training for Geographic Research," *Annals*, Association of American Geographers, Vol. 36 (1946), p. 212.

[17] *Status and Trends of Geography*, p. 12.

[18] O. H. K. Spate, "Quantity and Quality in Geography," *Annals*, Association of American Geographers, Vol. 50 (1960), p. 377.

ter confront us with questions wherever we look at them." The difficulty of course is that to get to the bottom of any basic question one needs a different training than is offered for prospective geography teachers by present-day Departments.

There has never been any doubt that to do acceptable work in any of the physical branches of geography such as geomorphology, climatology, hydrology, or pedology, mastery of mathematics and physics, together with an extensive knowledge of chemistry, are required. The present work of the regional scientists being published in the *Journal of Regional Science*, some of which is outstanding, brings into focus the need for genuine competence in mathematics in regional geography as well. I have been urging this need on the part of geographers for many years. One of my colleagues of a generation ago dismissed the matter by saying, "When I have a mathematical problem I will hire a mathematician to solve it for me." Needless to say, he never had a mathematical problem because he could not know what mathematics could do for him. During recent years a few young geographers have demonstrated the power of modern mathematical and physical science by using them in the solution of problems in economic and cultural geography and in various population problems. I must admit that some nonsense has appeared also. We have much evidence, however, that the student who has mastered any of the systematic branches of geography, and who has a solid foundation in physical science to back it up, makes a better geographer. These are the ones who can perform creditably when they are required to do something other than train the teachers of undergraduate courses in geography.

THE PLACE OF CLIMATOLOGY IN GEOGRAPHY

I believe that I can make my point clear by use of an example from climatology. Climatology is considered to be a branch of geography, and rightly so. Probably, nearly every Geography Department has a course or two in climatology, but not necessarily someone who is really qualified to teach them. There are no prerequisites, usually, and I suspect that some of the students may not even have had ninth grade General Science in preparation. It is accordingly on the high school general science level.

The students have already been introduced to climatology in the first course in geography. The beginning course describes the origins of climatology in ancient Greece. It explains that *climate* originally meant *slope* and referred to the curvature of the earth's surface which produced a sloping up to the south and a slope down to the north and brought about a threefold division of the earth into Torrid, Temperate, and Frigid zones. It introduces him to Aristotle's deduction that the "habitable world" was confined to the temperate zone between the Torrid and Frigid zones which were uninhabitable because of excessive heat and cold, and that there must be a corresponding temperate belt in the southern hemisphere, habitable but utterly inaccessible, being cut off by the impassable equatorial zone. The student will learn that the five original climatic zones were eventually subdivided into twenty-four parallel belts or climates delimited by parallels of latitude; the longest day within each belt varying by one-half hour between twelve hours at the equator and twenty-four hours at each polar circle. The professor thereupon warns the student that "Aristotle's brilliant generalization [of 2300 years ago] concerning the earth's climatic zones can only be presented as a stage in the learning process, and not as a concept that is valid today."[19]

The student will be told that the term *climate* has been used in this sense almost up to modern times, although the geographical exploration that began about A.D. 1450 showed that climates are not simple latitude belts, but are instead usually highly irregular areas exhibiting contrasts in moisture supply as well as solar heat. The pattern of climate is described as a reflection of the general circulation of the atmosphere, which in turn is strongly affected by the distribution, orientation, and configuration of the great land masses and water bodies over the earth's surface. This new direction was given impetus with the development of instruments, the making of observations, and the accumulation of data which could give quantitative expression

[19] Preston E. James, "The Hard Core of Geography," in *New Viewpoints in Geography*, Preston E. James, ed., *29th Yearbook of the National Council for the Social Studies* (Washington, D.C., 1959), p. 7.

to the regional differences in temperature, precipitation, wind, and pressure.

Carl Sauer brought into focus the geographers' concern with climate by reminding them that "the resemblance or contrast between natural landscapes in the large is primarily a matter of climate" and that "under a given climate a distinctive landscape will develop in time."[20] Geographers have concerned themselves with climate because they have believed that there are on the earth's surface natural climatic regions that are reasonably homogeneous and that have boundaries which can be identified in terms of plant communities, soil groups, and landform types and can be defined in terms of numerical climatic data. In short, they have seen in climate a key to the areal differentiation of the earth. This insight has led to a preoccupation with climatic classification. But not much was really demanded of climatic classifications and Sauer's view of 35 years ago probably expresses the majority opinion among geographers today. Sauer said,

> In spite of very scant knowledge of the origin of climatic conditions, the facts of climate have been summarized in terms of their geographic significance most admirably. In particular Köppen's series of trials at climatic synthesis, carefully developed as to biotically critical values, admirably restrained as to genetic explanation, are among the most important if not the most important contribution in this generation to a general geographic morphology.[21]

In harmony with this view, the climatology course for geographers teaches the ground rules for two or three of the classifications and gives the student the task of classifying a few stations according to the various systems. He may also check his results against surveys of vegetation and soils to enable him to say which system is "best." The climatic regions thus established become pigeonholes into which various miscellaneous geographic facts may be filed, and the main body of the climatology course consists of taking inventory of what is to be found in each of the pigeonholes. Here again we see the effect of a preoccupation with teaching. The classification is judged on how readily it can be presented in the classroom and not on how powerful it may be in the solution of geographic and other problems.

[20] Carl O. Sauer, "The Morphology of Landscape," *University of California Publications in Geography*, Vol. 2, No. 2 (1925), p. 39.

[21] *Ibid.*, p. 33.

NEW DEVELOPMENTS IN CLIMATOLOGY

The science of climatology meanwhile, unknown to most geographers, has made much progress. Two aspects of the field have been organized and both are being cultivated with vigor. They are dynamic and physical climatology. I have previously had occasion to discuss this encouraging development and the next several paragraphs have been borrowed from an earlier paper.[22]

Modern researches in physical climatology show us that climates owe their individual characteristics to the nature of the exchange of momentum, heat, and moisture between the earth's surface and the atmosphere. The climate at a place represents the existing balance between incoming and outgoing fluxes of heat and moisture.

In this sense, of course, the words "incoming" and "outgoing" must be interpreted horizontally as well as vertically. The horizontal component in the total flux is what we call "advection," which belongs in the province of dynamic climatology. In general, advection is slow by comparison with the vertical fluxes; the latter depend on radiative and turbulent exchanges parallel to very strong gradients of temperature and humidity, and are of a higher order of magnitude at most times than advection. The physical climatologist therefore concentrates mainly on determining the vertical heat and moisture balances for a given locality.

To evaluate the heat balance it is necessary to determine rates and amounts of solar radiation, reflectivity, and emissivity of various types of surfaces such as bare soils, vegetation-covered ground, water bodies, and snow and ice where it occurs. It is necessary to measure soil temperature at different depths and to determine the thermal properties of the soil material. Finally, it is necessary to determine the distribution of temperature with

[22] C. W. Thornthwaite, "Introduction to Arid Zone Climatology," Opening Address at the Australia–Unesco Symposium on Arid Zone Climatology, Canberra, Australia, October, 1956, in *Climatology and Microclimatology; Proceedings of the Canberra Symposium* (Paris: UNESCO, 1958), pp. 15–31.

height in the lowest several meters of the atmosphere.

To evaluate the water balance involves knowledge of the amount and distribution of precipitation, the variation in the amount of interception of water by plants, infiltration into the ground, and runoff from the various types of land surfaces and vegetation covers. In addition, the rate and amount of moisture transfer from the soil and vegetation cover to the atmosphere must be measured. To complete the moisture balance it is necessary to know the variation with depth of the soil moisture, the rate of moisture transfer through different soil materials, and the distribution of moisture with height in the atmosphere just above the ground surface.

Thus the proper field for study in climatology is not limited to the atmosphere alone but must include the land surface as well. Any region is a composite of innumerable local climates; the climate of the ravine, of the south-facing slope, of the hilltop, of the meadow, of the cornfield, of the woods, of the bare rocky ledge. Both the heat and moisture exchange vary from the ravine, to the hilltop, and to the rocky ledge, because of variation in the physical characteristics, position, exposure, and aspect of these diverse surfaces. The color, apparent density, heat capacity, moisture content, and permeability of the soil; the characteristics of the vegetation cover; the albedo and roughness of the surface; these are all factors that influence the heat and moisture exchange and are thus important climatic factors. This brief inventory of the content of climatology should leave no doubt that mastery of the field cannot be attained without an adequate background in physics and mathematics. It will also show that climatology is geography.

Ordinarily, the terms macro-, meso-, and microclimate designate different scales of area with microclimate referring to the climate of the very small space. The geographers use four terms that relate to different sizes of area; cosmography is the description of the cosmos or the universe, geography refers to a description of the whole earth, chorography to a region such as southern New Jersey, and topography refers to the description of a place. The old topographies, popular in England two centuries ago, were detailed descriptions of places of very limited area—fields or villages. Thus, by analogy, the climate of a small space might be called topoclimate and its study, topoclimatology.

The word, "topoclimatology," could substitute for microclimatology to mean the study of the climate of a place. But it has a better use, which can be derived by considering the content of climatology itself. Since climates owe their individual characteristics to the nature of the exchange of momentum, heat, and of moisture between the earth's surface and the atmosphere, then climatology must study the earth's surface as well as the atmosphere. It would be proper to assign to topoclimatology the task of determining the physical properties of the earth's surface that share in the development of the climates.

A TASK FOR GEOGRAPHERS IN CLIMATOLOGY

In topoclimatology the study of climate takes a new aspect. Climatology has been an armchair study. The task of the climatologist presumably has been to salvage and analyze meteorological observations as meteorologists discard them. But the complete study of climatology involves field work. It involves detailed study of certain aspects of the land. It is essential in topoclimatology to make surveys and to map the aspects of the soil that affect the heat and moisture balance. These studies involve methods of mapping that have been developed by geographers and soil surveyors. Still, the pedologist has never concerned himself with the mapping of the heat capacity or heat conductivity of the soil. No geographer has ever attempted to map the qualities of vegetation that determine the surface roughness and condition the vertical wind profile or that determine the evapotranspiration and thus the soil moisture. No such maps have ever been made anywhere even experimentally.

Some geographers have experimented with the mapping of elements of slope and with what they call surface configuration. They have never made such maps, however, to assist in the interpretation of the heat and moisture balance. Unless a climatologist has had basic training in geomorphology and in soil science, he will be poorly equipped to work in this phase of climatology. Conversely, ordinary geomorphologists and soil surveyors will not have the understanding of the objectives of

climatology to lead them to make such studies. Teams consisting of climatologists and soil scientists working together could do well in this field.

It is necessary to emphasize the importance of mapping the characteristics of the surface that influence the exchange of heat, moisture, and momentum. Hare and his associates have made a map of albedo of Labrador, Canada, on a scale of 1:5,000,000. Lettau and his students are at work on a corresponding map of aerodynamic roughness. Maps showing the distribution of soil moisture in detail are similarly needed. Those elements which are of importance in heat and moisture exchange vary from season to season and in some instances from day to day. But to understand the heat and moisture exchange, it is necessary to produce maps showing these factors. Some years ago I published small-scale maps of the United States showing the concentration of moisture in the soil at the end of each of the twelve months. These were highly generalized maps. To achieve the program that is herein outlined, it will be necessary to make such maps on large scale. Maps of soil moisture would show the effect of soil texture, slope, and topographic situation on the water content. Such maps of soil moisture would aid immeasurably in an understanding of the water balance of a small area. The ultimate objective of climatology would be to use the maps of heat budget and moisture budget in building up climatic generalizations. Generalization from such local studies would greatly enhance our understanding of climates of large regions.

During the last several months the members of our research group at the Laboratory of Climatology have made some new discoveries in topoclimatology and have gained a new appreciation of its complexity. A problem of the Army had involved us in a study of vertical winds in typical terrain. We developed an instrument system for measuring the vertical component of the wind, and used it for making observations at different heights in a number of different locations in our area around Centerton, New Jersey. We were surprised to find in an extensive, uniform, nearly level field that day after day some spots show a predisposition to updrafts and others to downdrafts. This simple observation was unexpected because it has always been assumed that the mean vertical velocity of the wind is zero—in other words, that updrafts in a place must be balanced by downdrafts there. This assumption is basic to some micrometeorological theory. Since it must be true over any large tract of country, to preserve continuity, it follows that for each area of dominantly upward flow there must be somewhere nearby an equivalent area of downflow, with horizontal convergences between them. This conclusion opens up the prospect that appreciable local differences in total flux of heat, water vapor, and momentum must arise from the adjustment of wind streamlines to topographic obstacles and irregularities. It may well be that in some instances these are the most important differences in determining the locally observed topoclimates.[23]

There is not time to follow this trail further. I will leave it by reminding you that there is much to be done in climatology, and much for the geographer to do. When he gets deeply involved in problems of heat and moisture exchange and of topoclimatology, he will see how inconsequential are the familiar exercises in climatic classification. If "there is a climatology of agriculture, of aviation, of health, of clothing, of housing, of tourism, and so forth,"[24] as Stephen Jones avers, then they are all made one through the unifying power of the heat balance and the moisture balance. My associates and I have been working for a long time on problems of heat and moisture exchange, and since 1953 not less than twenty-two of the publications of our Laboratory have dealt with the water balance and have outlined various of its practical applications. I fear that these publications are largely unknown to most professional geographers, although I should like to feel that they embrace the geographical point-of-view and point the

[23] C. W. Thornthwaite, W. J. Superior, J. R. Mather, and F. K. Hare, "The Measurement of Vertical Winds and Momentum Flux," *C. W. Thornthwaite Associates Laboratory of Climatology, Publications in Climatology*, Vol. 14, No. 1 (1961), pp. 1–89; and C. W. Thornthwaite, W. J. Superior, and J. R. Mather, "Vertical Winds Near the Ground at Centerton, N. J.," *C. W. Thornthwaite Associates Laboratory of Climatology, Publications in Climatology*, Vol. 14, No. 2 (1961), pp. 91–244.

[24] Stephen Jones, "What Does Geography Need from Climatology?" *The Professional Geographer*, N. S., Vol. 2 (1950), p. 43.

way to the solution of some important geographic problems.

SOVIET AND U. S. DEVELOPMENTS IN PHYSICAL GEOGRAPHY

The very useful new publication of the American Geographical Society, *Soviet Geography*, gives most of us our first glimpse of what is going on in the Russian geographical world. Every issue in the first half of 1961 has taken notice of the "problem of the heat and moisture balance of the earth's surface." The Third Congress of the Geographical Society of the U.S.S.R., meeting in Kiev in February, 1960, adopted a series of resolutions outlining the role geographers should play in this research. It noted:

> . . . that the problem of the heat and moisture balance has now acquired great significance for the development of the theory of physical geography . . . uniting the whole system of geographic scientific disciplines and permitting transition from the descriptive methods of studying the geographic envelope of the earth to more precise quantitative methods ascertaining the physical essence of the interactions between natural processes and phenomena . . . it is resolved to recognize the significance of the problem of the heat and moisture balance of the earth's surface for the further development of the scientific theory of physical geography, for the transition of geography to modern research methods and for a sharp enhancement of its general significance in the national economy of the USSR.[25]

Furthermore, the Russian geographers took note of the new intensification of physical geography and what is translated as "landscape science." Among several resolutions there was one to concentrate the efforts of geographers upon working out methods of quantitative characterization of landscapes on the basis of the study of the moisture and heat balance in landscapes, and to undertake concrete measures to introduce new physical and chemical methods into landscape and paleogeographic research, including the organization of a commission on questions of the application of modern physical and chemical methods in geography.[26]

The Russian geographers have outlined a large program for themselves in taking up the problems of the heat and moisture balance of the earth's surface. They have well phrased it in one of the resolutions: "*uniting the whole system of geographic scientific disciplines and permitting transition from the descriptive methods of studying the geographic envelope of the earth to more precise quantitative methods ascertaining the physical essence of the interactions between natural processes and phenomena.*"[27] It is a program that arouses my keenest interest, because it is precisely what I have been working on for the major part of my career. It is a direction that geography should take. I think that we should be in as close touch with these important developments as we can be and that in some center of learning in this country we too should undertake to reshape geographic theory on the basis of heat and moisture exchange.

As I return again to Leighly's challenge that "The land, the sky, and the water confront us with questions wherever we look at them," I would remind you that these are traditionally the three branches of geography. Yet today the sky is being investigated very effectively by the atmospheric scientists (as the meteorologists are beginning to call themselves) and the water by the oceanographers. A similar massive assault on the problems of the land is shaping up, and the geographers should participate in it.

I wish that there were time for me to tell you how the atmospheric scientists and the oceanographers have gone about organizing research and teaching in their sciences, how they have sought support for their program, and how successful they have been. Ten-year goals have been established in oceanography, and a program in atmospheric science for the next ten years, which has been hammered out this summer, will be considered by the Federal Council for Science and Technology in its September, 1961 meeting. This is a part of the work of the President's Science Advisory Committee on broad planning for the sciences. That Congress is also taking a hand is shown by a question which Senator Hubert Humphrey asked the Secretary of the American Meteorological Society in a letter dated June 8, 1961: "Do you believe that the Legislative and Executive Branches of the U. S. Government are at present adequately

[25] "General Resolution of the Third Congress of the Geographical Society of the USSR," *Soviet Geography: Review and Translation*, Vol. 2 (1961), p. 70.
[26] *Ibid.*, p. 71.
[27] *Ibid.*, p. 70.

providing on a systematic long-range basis to assure the fullest development of the state of the art of meteorology? If not what should be done on a long-range basis?"

The oceanography program has been launched. In fact, the President of the United States has urged it forward in two of his major addresses. There is little doubt that the program in atmospheric science will move forward with full support of Congress and the Administration. Since it was put together by the best brains of the nation, with the assistance of experts from several foreign countries, under the direction of the distinguished meteorologist Sverre Petterssen, I believe that it is a very good program, indeed.

When testifying before the House Committee on Science and Astronautics, Petterssen referred to the growing importance of the "environmental and resources sciences." He said:

> With the projected increase in the world population and with an enormous increase in the standard of living of billions of people throughout the world, the demand on our resources will rise correspondingly, with the result that the sciences which deal with man's environment and the resources at his disposal will become as important tomorrow as are the engineering sciences today. To prepare for the future the universities should amplify their activities in geophysics and planetary sciences by a several-fold factor.[28]

Working groups organized by a committee of the National Academy in response to a request by President Kennedy have been meeting this summer to determine our national needs for natural resources and to construct programs of research for their conservation and renewal. The latest briefing in the series for the Committee on Renewable Resources was concluded less than two weeks ago, on August 18. Considering the present mood of the Federal Administration to improve and expand research in this country, I am convinced that there will be a rapid acceleration of research in the resource field, and a great increase in support of it. Let us hope that geographers will participate in this important program. Opportunity is knocking.

The research that will gain respect for the geographer in the scientific community will be done by those men who have mastered a systematic field. I can see a vast array of climatic problems that will demand solution as we seek ways to conserve our resources and to utilize them more efficiently. Those in other geographic fields doubtless will have contributions to make. The task here is not to produce surveys or inventories of resources, to map out their geographic distribution, or to write more textbooks on economic geography, but for those who can to show how to stretch or expand the earth's resources to feed, clothe, and house the world's rapidly growing population. What, for example, would it mean to the world if we should find some way to increase the efficiency of use of water by plants so as to reduce the waste from transpiration?

TRAINING FOR RESEARCH

We can learn much from oceanography, which was at one time regional marine geography. Professional oceanographers of the present are in reality marine meteorologists, marine biologists, marine geologists, chemists, and so forth. There is no pretense that "professional" oceanographers can be produced all in one mold by following a prescribed course of study. The problems of the land are far more varied and complex than those of the oceans and it should be apparent that no standardized curriculum for mass-producing geographers can possibly give the needed training for genuinely productive research in geography.

We recognize a legitimate need for two kinds of Geography Department, one to teach undergraduates and the other to teach the teachers. I see a need for a third kind of Geography Department, to do the fundamental research and to train the researchers. It will be argued that such Departments already exist, but if they do, there is room for more of them. It must be understood that the training for future teachers of undergraduate geography is not adequate for future geographical scientists. This Department would be staffed by men who had mastered various of the systematic fields. They would come from the outside. Once the new Department came into existence, student training for research would begin and soon the research effort could be expanded. The teaching responsibility in the research Department is very

[28] Sverre Petterssen, "New Needs in Geophysical and Planetary Sciences," in *Report of the Committee on Science and Astronautics* (U. S. House of Representatives, Eighty-Seventh Congress, First Session, Washington, D.C., 1961).

important, not only because it would produce the new talent, but also because it would provide a stimulus to the researcher. We must not forget that it is the student who teaches the professor.

My own interests are on the physical side, and if I were invited to make suggestions for the organization of a first research Department of Geography, I would repeat what I have already said this evening: "In some center of learning in this country we should undertake to reshape geographic theory on the basis of heat and moisture exchange." Modern climatology is still in its beginnings. We are still measuring and mapping temperature and precipitation, although we know that our need is rather to measure the fluxes of sensible heat and water vapor. We cannot yet measure these fluxes very well and still have no suitable instrument for measuring net radiation. Even so, the new concepts in climatology stand ready to bring about revolutions in geomorphology and soil science, and certainly in plant geography and phenology. They have already been very influential in hydrology.

The research of this Department would not stop with physical geography. Nearly ten years ago Curry[29] showed how economic geography could be given new life through the application of these modern climatic concepts, and recently Warntz[30] has rediscovered this important research possibility; but only the merest beginning has been made. I am convinced that every aspect of geography would be improved and strengthened through application of the heat and water balance, that geography would come to grips with important practical problems, and that shortly new and fresh material would find its way into the teaching Departments. Already a high school teacher in Chicago is presenting the water balance to his students.[31]

Cultural geography is a respected subdivision of the field, but I have not discussed it because I feel that it has not been neglected to quite the extent that physical geography has. To do good work in cultural geography a mastery of economics, demography, and historiography is required in addition to the requirements for physical geography. With that degree of competence we could expect work which would compare with the Swedish settlement studies, which are as valid and sound as any physical studies could be.[32]

Physical geography has been neglected in the United States because geographers have neglected mathematics and physics in their undergraduate training. Most geography curricula in this country do not include any physical science whatsoever. This is why there is a distinction between "meteorological" and "geographical" climatology. Leighly said that "we forfeit our claim to respect if we accept that distinction, or admit . . . that what the meteorologists write is 'beyond the intellectual reach of the geographer.'"[33] I made essentially the same point several years ago in a book review, suggesting that "there is no real reason why we should have one climatology for geographers and another for meteorologists," and urging that the author should "write the book that needs to be written, leaving it to the student to prepare himself as he should for using it."[34] Kenneth Hare has warned that the climatic accounts in regional studies must be written with "rigor and sophistication in order to avoid mediocrity."[35]

The inadequate training in geography has been exposed repeatedly in the methodological literature of the last decade, and some Departments have taken steps to stiffen the requirements. It is still true, however, judging from my study of University catalogs, that most Departments list many courses and permit, or even require, the student to take 25–30 of them, thus preventing him from getting needed courses elsewhere in the University and effectively depriving him of a college edu-

[29] Leslie Curry, "Climate and Economic Life: A New Approach," *Geographical Review*, Vol. 42 (1952), pp. 367–383.

[30] William Warntz, "Progress in Economic Geography," *New Viewpoints in Geography*, *op. cit.*, p. 72.

[31] Marlowe J. Hartzer, "Can the Water Balance Principle Be Taught to High School Students?" (processed).

[32] For example, see John B. Leighly, "The Towns of Mälardalen in Sweden: A Study in Urban Morphology," *University of California Publications in Geography*, Vol. 3 (1928), pp. 1–134.

[33] John Leighly, "What Has Happened to Physical Geography?" *op. cit.*, p. 317.

[34] C. W. Thornthwaite, Review of "An Introduction to Climate" by Glenn T. Trewartha, *Science*, Vol. 120 (1954), pp. 1,067–1,068.

[35] F. Kenneth Hare, "Dynamic and Synoptic Climatology," *Annals*, Association of American Geographers, Vol. 45 (1955), p. 162.

cation. Small Departments may list many courses too, even when there is only one man to teach them all. When a man's offering includes courses in human, political, agricultural, urban, and industrial geography, North America, Latin America, Africa, and the U.S.S.R., and introductory and advanced climatology, they are likely to be so superficial and devoid of substance as to be largely a waste of the student's time.

Whether this trend may be reversed is not for me to say. In one Department the undergraduate requirements for the physical geography major include thirteen courses in mathematics, physics, chemistry, and geology plus only three courses in geography. Any student who has mastered this program will be prepared to enter upon graduate work in physical geography and could work effectively in climatology after having acquired a good background in meteorology. This program is beginning to attract students. The program of study in the social sciences is likewise undergoing revision. A rigorous program of mathematics, mathematical probability, mathematical statistics, and, of course, economics will be prerequisite to work in certain aspects of economic geography. This trend may be accelerated through the influence of the Institute on Quantitative Methods in Geography that has been conducted in the Chicago area this summer. The chairman of one Department reports that the few regional courses that are offered are service courses for non-geographers, and are not open to geography majors. Most of the requirements for the major are satisfied with courses in other Departments. I do not intend to outline a desired course of study for geography this evening, but I know that a thoroughgoing study of needed curriculum revision throughout the country should be undertaken.

The mathematicians are currently wrestling with a problem in mathematics education which should help us to understand the present situation in geography. The proposed solution was outlined recently in an editorial in *Science*.[36] The enrollment in mathematics courses is growing much faster than total enrollment in college. At the same time the number of mathematics teachers with Ph.D.'s is diminishing, because so many are going into government and industry. Accordingly, the members of a committee have proposed that the requirements for mathematics teachers be relaxed. At the present time a candidate for the doctorate in mathematics must pass preliminary examinations and write a dissertation offering some new and interesting mathematical proofs, on the assumption that one must be a creative mathematician in order to teach mathematics. Questioning this assumption, the committee suggested an alternative program of study in which the creative dissertation is replaced by "a scholarly dissertation which could be historical, critical, or philosophical." It was claimed that such research would give suitable preparation for effective teaching and would result in something of value to the mathematical community as well. To distinguish the new program from the traditional one, there would be a new graduate degree in mathematics, the Doctor of Arts. It was feared, however, that a new program of study would create "class distinction among mathematicians, with the upper and lower classes regarding each other with condescension on the one side and envy on the other." A key question posed by the *Science* editorial is whether its proponents really mean it when they say that the new kind of dissertation would be both preparation for teaching and a contribution to scholarship. The mathematicians emphasized the distinction between the "creative" study, which adds to the store of mathematical knowledge, and the "scholarly" study, whether historical, critical or philosophical, which does not. In geography we have historical, critical, and philosophical studies as well as regional studies. They may all be admitted as a form of scholarship, but they do not add to our knowledge of the earth nor give us any new insights into the "application of the laws of nature upon the earth" and would thus be accorded a lower place if we were to adopt the same class distinctions.

It seems to me that the various diverse points of view can be reconciled. We must recognize that there is need in geography for undergraduate and graduate teaching and that the beginning course may very suitably have a regional organization. It must be recognized, however, that the training for teaching such a course does not prepare one for a

[36] Joseph Turner, "How to Let Go and Still Hold the Line," *Science*, Vol. 133 (1961), p. 1,079.

career in research or to work effectively in business, industry, or government. There is thus a need for a more rigorous training of geographers, in which we would be asking our students to get a better education than we ourselves have had. This is my sole thesis. Wherever possible, we should bring into the Department men who can see that the next generation of geographers will indeed be better trained to deal with all aspects of geography. And I would hope that among this new crop of geographers there will be those who will realize that the field of geography is not man but the earth, and that the earth must be "studied in its own terms and for its own sake."[37]

[37] "What Has Happened to Physical Geography?" *op. cit.*, p. 309.

THE OREGON TRAIL AND UNION PACIFIC RAILROAD: A CONTRAST IN PURPOSE[1]

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IN American historical geography the assumption has often been made that routeways are characterized by continuous use. The Indian track becomes the pioneer's trail, and the pioneer's trail the railroad alignment. This mode of thinking rests on the relative coincidence of various routes, such as the Mohawk Depression of New York where Indian track and toll road represent boundaries in time of a long series of transportation ways of similar location. It is a basic premise that all movement has similar causes and, thereby, coincident locational requirements. Such thinking may serve well in the case cited, for in the Mohawk Depression the Indian track was a line of trade as is the New York Thruway; but in a number of instances the failure to distinguish the purpose of travel at various times may hide the reason for the abandonment of once important routes. Perhaps the most striking example of this obscuration is the failure of the concept of continuous use to fit the history of the Oregon Trail. That most important route of internal migration remains now mainly in a fossil form which is not easy to find. Modern transportation in the area depends so consistently on a different route that we face a true enigma as to the previous importance and present disuse of so extended and significant a tie of the East and West.

The abandonment of the Oregon Trail is even more difficult to explain than that of other tracks, such as the Natchez Trace, because the areas it connected have grown closer together in economic ties during the past century. Under any assumption of continuing, if technologically up-dated use, we should expect to find the Oregon Trail within our trunk highway system today. That it is not included puts the assumption of locational succession in doubt. The transcontinental crossing of the middle tier of the United States continues to be important in transportation geography, but it is secured along an alignment that is different from the initial route.

Succession with respect to transportation is obviously more than a technical improvement with geographical conditions remaining unchanged. To explain the shift in the location of a route which continues to connect the same general termini is the problem of this paper. We may rule out secular changes in climate and the physical environment, and the small dependence of this transcontinental route on local business would seem to exclude the economic and demographic geography of the area as a cause. The two possible explanations of the shift seem to be (1) a much changed purpose for the travel, and (2) a sharp decline in the dependence on local resources since the time of the Oregon Trail movement.

Although there are many purposes for travel —journeys-to-work, journeys-to-shop, for recreation, for migration, and the transport of raw materials, fabricated materials, or consumer products—these may be summed under two groups. The first might be called *economic transportation* and would indicate that the purpose is to carry goods or people in the hope of profit from that activity. In this group profit should be understood not as the product of transportation within limited sectors, but of the operation over a complete route. Profit and loss in the parts are averaged out and if the net return for the full operation is favorable, it is possible to undertake transportation in a part where local movement would be economically disastrous. The crossing of the Rockies is a case in point. The amortization of the construction cost for railroads or roads added to the high operating costs would make it difficult to profit here. But these mountain roads and railroads exist to connect distant termini rather than the two sides of the range. Even though this is an obvious fact, its tie with the purpose of travel may not be quite so well understood. In economic travel the ability to shift costs from one sector to another

[1] The author wishes to express appreciation to the Union Pacific Railroad for assistance given to him in securing information for this study, and to the Graduate College of the University of Wyoming for a field research grant.

means that locally unprofitable sectors can be built and operated to reduce the *overall* cost of operation through shortening the line, reducing the maximum grade, or securing better working conditions in winter. In economic transportation almost any barrier can be surmounted if the benefit to the total operation can justify the cost. From this it follows that the geographical location criteria of economic transportation depend as much on national or world economic geography as local physical or economic geography.

The second group by purposes combines those movements that measure success in terms other than profit, i.e., *non-economic transportation*. The Oregon Trail typifies a route for such travel. Success was measured by arrival on the Pacific Coast, not by what it cost or how much could be carried. Few emigrants reached Oregon with many goods or much livestock. Even though many left "the United States" for the frontier due to economic hardship, it might be questioned whether they themselves ever profited economically from the move. This movement was certainly fully as psychological and political as it was economic. With at best no immediate profit to shift, each part of the journey had to be as free of cost as possible. It might be argued that they left the settled area with resources and this was a shifting of costs, but closer examination shows that the resources they brought could not secure passage for them. Neither furniture nor money had any value beyond the frontier, either in providing transport or in securing food. No sector of the journey could in its natural state be an insuperable barrier without breaking the whole thread. Thus, in non-economic travel geographical location criteria depend more strongly on local physical and economic geography.

This distinction between economic and non-economic transportation has more than historical importance. Even today considerable movement, particularly of people, is directed by other than simple economic ends. An obvious example is recreational travel, which like the trek to Oregon seeks to make each sector of travel as "sustaining" as possible disregarding economic measures. Similarly, in metropolitan areas we do not apply a real cost-benefit measure to the provision of highways to distant suburban areas. If such were the case, much of the recent housing development is farther from the city than required by the urban physical structure. The justification for recreational roads or attenuated suburban arterials must be in terms other than economic need and profit. The analysis of the geographical location factors for transportation routes must take into consideration the existence of two types of transport, economic and non-economic, if we hope to know why and how our transportation patterns developed as they have.

Despite differing termini on the Pacific Coast, Oregon for the trail and California for the railroad, the two routes under consideration are broadly coincident in location east of Great Salt Lake. The trail and railroad cross in three places, and are nowhere more than a hundred miles apart except at their points of origin. It is approximately a thousand miles from "the middle border" at the Great Bend of the Missouri River to the western slope of the Rockies in the Salt Lake and Snake River plains, so that for a third of the width of the continent these routes run generally along a broadly parallel course. The Oregon Trail was demarcated by use in the early 1840's, and the Union Pacific Railroad by physical construction in the five years following the Civil War. For thirty years the Oregon Trail had an absolute importance serving as a migration way for a population estimated at above 300,000, of whom over a tenth died in passage.[2] Yet today its significance is totally historical and we may cite only two towns, Kearney, Nebraska and Casper, Wyoming, and a few hamlets which grew up from this movement. In fact, less than half the 1,200 miles of the trail from Independence, Missouri to Pocatello, Idaho is followed even by minor roads, and this is more a commentary on the ubiquity of roads in the United States than on the lasting importance of the trail. Only for short stretches are these roads major highways. The railroad, on the other hand, has brought into existence a string of towns between Omaha and Ogden which, though small in absolute size, are the dominant ones in this tier of the Great Plains

[2] U. S. Congress, House Committee on Roads, Hearings Before the Committee on Roads, House of Representatives, 68th. Congress, 2nd. Session, *The Old Oregon Trail* (Washington: G.P.O., 1925), p. 24.

and the Rockies. And throughout the 1,086 miles between these two cities both highways and airlines follow the railroad. The first transcontinental airline guided on the railroad between Omaha and Ogden,[3] and the first all-weather transcontinental highway lay close alongside the track.[4] The contrasting fates of these two parallel routes suggests that here we may well hope to find what distinguishes the short-term physical connection from the lasting economic tie.

THE PIONEER TRACK

The Oregon Trail was markedly a physical connection in a form early developed in America. In the 1630's the Massachusetts Bay Colony settlers wished first to visit and later to settle in the "interior" along the Connecticut River, so the Bay Path was opened through the forests, with the minimum expenditure of labor and capital. Only a half century later, when commerce had grown up, could expenditures be made in sufficient measure to allow an economic rather than a natural route to be established—that formed by the Upper Boston Post Road to Springfield. Similarly, in the Middle Colonies the Wilderness Road was the capital and labor-saving expedient for the opening of Transylvania. When grain and cattle became trade goods commanding a price on the eastern seaboard it was possible to build first Braddock's Road, and later the New York and Pennsylvania canals. Repeatedly the non-economic preceded the economic route, and only where rivers provided a "free" route that was also a practicable channel of commerce does this replacement seem to have been delayed until the coming of railroads. In the Ohio and Missouri valleys the rivers served as pioneer trace and later as freight line. In the case of the farther westward advance of American settlement, however, the rivers gave out and a return to the land trace had to be made to carry the frontier to the Pacific. In this context the Oregon Trail was in the American tradition of transportation geography.

THE OREGON TRAIL

In any discussion of the development of transportation in the United States the Oregon Trail assumes particular interest for several reasons. This track was the longest of any of the "natural routes" which pioneers made passable rapidly and with small cost in their search for a way forward. Also, because it was the last of these tracks, it was the most crowded. During years of peak flow the migrants were numbered in the thousands. The aridity of the West and the magnitude of migration made the balance between natural endowments and needs of the travelers precarious. In a very real sense this was the epitome of the "natural route," and certainly this fact has made of its history a truly heroic mythology in less than a century. However, it has a more workaday significance. The Oregon Trail, because it has so completely disappeared into history, permits us to evaluate, both from published accounts and from undisturbed remains, the geographical conditions which located and supported the track and the deficiencies which closed it to economic travel.

The key to the broad scale location of the Oregon Trail was the stagnant American frontier at the Great Bend of the Missouri, where westerly advance stopped for twenty years soon after 1820. As Webb has said:

> Upon this barrier of the Great Plains the pioneers threw themselves, armed and equipped with the weapons, tools, ideas, and institutions which had served them so well in the woods that now lay behind them. Inevitably they failed in their first efforts, and they continued to fail until they worked out a technique of pioneering adapted to the Plains rather than to the woodland.[5]

At the margin of the plains several towns had grown up, most notable of which were Independence, Westport Landing (Kansas City), and St. Joseph in Missouri. In this area the

[3] United States Air Mail service began in 1919 and was, until 1924, by air during the day and by rail at night along a route following the Union Pacific Railroad in its territory. Even when flying speeds and navigation improved, and night-flying was possible, Boeing Air Transport Inc., which took over from the U. S. Army Air Corps in 1927, continued to follow the railroad. Its successor company, United Airlines, retained this practice nearly to the time of jet plane travel in the late 1950's.

[4] The Lincoln Highway (essentially U. S. Route 30-30S in the study area) was the first transcontinental route with an all-weather surface on completion of the Ely, Nevada to Wendover, Utah section in 1930. U. S. Route 30-30S is never more than twenty miles from the Union Pacific and is generally within sight of the track.

[5] Walter Prescott Webb, *The Great Plains* (Boston: Ginn and Company, 1931), p. 141.

river was both natural route and economic line, as elsewhere in the Middle West of the early nineteenth century, and it was the most important factor establishing this settlement. Above Westport Landing it was so difficult to navigate that the river was seldom used, though at one time or another paddle boats did ascend as far as Fort Benton, Montana. Also at the Great Bend the change in direction of upstream navigation from west to north further reduced the appeal of the river route. Two of the right-bank tributaries of the Missouri for a time held out hope for navigation. The Kansas, which joins at present-day Kansas City, was soon found useless, and the Platte, which flows into the Missouri two hundred miles above, was equally unprofitable. Robert Stuart, who was the first to attempt to navigate the western and central reaches of the Platte, reported in his diary for January 22, 1813: "the river running East South East so shallow as makes us happy at having abandoned our Canoes for its bed is for the most part upwards of a mile wide and the sandbars so numerous and flat that it would require more water than we have any right to expect to have it made fit for our purposes."[6] This may well have been the origin of the archetypal description of the Platte as "a mile wide and an inch deep," and the disdain reflected in a statement, attributed to one of the travelers to Oregon, that its sand and snag choked course was that of a river "flowing bottom-side-up."[7]

With no rivers to use and a landscape of inhospitable grass to the West, the agricultural frontier hung on the Great Bend for twenty years. As Bernard De Voto remarked, "Though the land remained a continuum, an ellipsis interrupted its coherence."[8] The ellipsis was the "Great American Desert," which "for the first half of the nineteenth century, and in some quarters until after the Civil War, . . . existed in the public mind . . . situated to the east of the Rocky Mountains. . . . It was a reality in the minds of the people of that time. To them the region was actually a desert, wholly uninhabitable with the methods and implements and instruments of pioneering which had been previously used east of the ninety-eighth meridian, and wholly undesirable."[9] The barrier of the plains was reached at a time when agricultural pioneers had begun to be aware that a forested land existed far to the west in Oregon. "It was the journey of Lewis and Clark that gave the American people a conviction that Oregon was theirs and this conviction was more important than the claim."[10] But between Westport Landing and the Willamette Valley two thousand miles of little-known land intervened. Lewis and Clark had shown the possibility of travel along the Missouri, though at a cost in time of two seasons of travel, and then only without wagons. If the frontier was to be carried over the Great American Desert and the jumble of mountains and true deserts farther to the west, a better route was needed.

With the development of the fur trade in the Rocky Mountains during the second quarter of the nineteenth century another attempt was made to navigate the Platte, but it met a fate as dismal as Stuart's. General Ashley, the leader of several trapping expeditions into the middle Rockies, soon concluded that the Platte was valueless as a water route, and paused to consider it as a land route. The result of this reappraisal was announced in the *Missouri Advocate and St. Louis Enquirer* on March 11, 1826 as a "NEW ROUTE to the Pacific Ocean, discovered by Genl. William H. Ashley, during his expedition to the Rocky Mountains."[11] More than a year before *The Arkansas Gazette* (then at Arkansas Post) noted: "By the arrival of Major Henry [Ashley's partner in the Rocky Mountain Fur Company] from the Rocky Mountains, we learn that his party have discovered a passage by which loaded waggons can at this time reach the navigable waters of the Columbia River. This route lies South of the one explored by Lewis and Clarke, [*sic*]

[6] *The Discovery of the Oregon Trail: Robert Stuart's Narratives of His Overland Trip from Astoria in 1812–13*, edited by P. A. Rollins (New York: Charles Scribner's Sons, 1935).

[7] Quoted in Irene D. Paden, *The Wake of the Prairie Schooner* (New York: Macmillan Company, 1943), p. 83.

[8] Bernard De Voto, *The Course of Empire* (Boston: Houghton Mifflin, 1952), p. 410.

[9] Webb, *op. cit.*, p. 152.

[10] Bernard De Voto, *The Journals of Lewis and Clark* (Boston: Houghton Mifflin, 1953), p. 1.

[11] Donald McKay Frost, "Notes on General Ashley, the Overland Trail, and South Pass," *Proceedings of the American Antiquarian Society*, October 18, 1944, p. 302.

and is inhabited by Indians friendly to us."[12] And even in the East this news was known. The *Alexandria* [Va.] *Gazette* noted in 1826:

> It has proved that the over land expeditions, in large bodies, may be made to that remote region [Oregon], without the necessity of transporting provisions for men or beast, . . . the animals keeping their strength and flesh on the grass which they found, and without losing any time on this long journey. The men also found an abundance of food. . . . The whole route lay through a level and open country, better for carriages than any turnpike road in the United States. Wagons and carriages could go with ease as far as General Ashley went, crossing the Rocky Mountains at the source of the north fork of the Platte. . . . From all that we can learn, the elevation is exceedingly small where the passage of the mountain was effected—so small as hardly to affect the rate of going of the caravan, and forming at the most, an angle of three degrees, being two degrees less than the steepest ascent on the Cumberland road.[13]

From these comments it is apparent that not only had the "natural route" been found, but also that its existence was widely publicized.

THE LINE OF THE TRAIL

The line of the Oregon Trail (Fig. 1) is intelligible in terms of its purpose. Its eastern terminus was obviously the western limit of settlement in the early 1840's, the Great Bend of the Missouri, where water transportation and forest reached a coincident termination. Given that place of origin, however, there must be some explanation of the final and almost exclusive use of the middle route along the Platte. In their expedition at the beginning of the century Lewis and Clark had found no very satisfactory route across the successive ranges of the northern Rockies. It is probable that none of the three different routes they took was practicable for wagons as an undeveloped route. De Voto wrote of Marias Pass, which opens from the Marias Fork of the Missouri to the headwaters of the Clark's Fork of the Columbia, that, "Except for the great portal of the West, South Pass through which the American emigration moved to the Pacific, it is the only pass by which wagons could have crossed the divide —and the short summer of the north closed it to emigrants."[14] Certainly present snow conditions in the area, though only roughly sketched by snow course data, suggest that mid-summer snow could have been a problem.[15] Even after an open winter the range of the Blackfoot Indians across the entrance to Marias Pass would have deterred most migrants.

Even when engineered routes were opened through Montana, such as Mullan's Road across the continental divide west of Helena which was "finished" in 1862, the effect on travelers to Oregon was slight. Turrentine Jackson, in his definitive study of the building of wagon roads in the West, remarks, "as a continuous avenue of transportation the northern overland route never rivalled the central route, either as it was known to the early pioneers, or as subsequently relocated."[16] In all he concludes that during the period of greatest use Mullan's Road served a group not greatly exceeding fourteen hundred persons.[17] The circuitous route from the Great Bend to the Montana Rockies, the rapidly growing timber, and the turbulent mountain streams which forced the road to perch on easily gullied benches in narrow canyons, robbed this route of importance for emigrants. Only when the Montana "diggings" were developed did this economic road come into its own as the link between Fort Benton at the head of Missouri navigation and the mining areas of western Montana.

The failure to develop any route at all across Colorado is easily explained. The passes in the Colorado Rockies are so high, at least 10,000 feet, and so steep that no natural wagon road existed. In addition, any engineered road would have led to the almost untraversable Utah plateau country before reaching the Salt Lake Basin.[17] Today these plateaus remain the

[12] *Ibid.*, p. 292 (Quotation dated Nov. 16, 1824).
[13] *Ibid.*, pp. 305–306.
[14] De Voto, *The Course of Empire*, p. 483.

[15] Several snow courses where detailed measurements are taken are located near Marias Pass, but in tributary valleys rather than on the summit. The data published for Marias Pass (in US Department of Agriculture, Soil Conservation Service, Summary of Snow Survey Measurements, Montana and Northern Wyoming, pp. 139–141) show snow prevailing on the relatively bare summit well into June in some years. On the protected and wooded west slope it is probable that snow could have been a problem even in mid-summer after a winter with a heavy fall.
[16] W. Turrentine Jackson, *Wagon Roads West* (Berkeley: University of California Press, 1952), p. 278.
[17] *Ibid.*, p. 276.

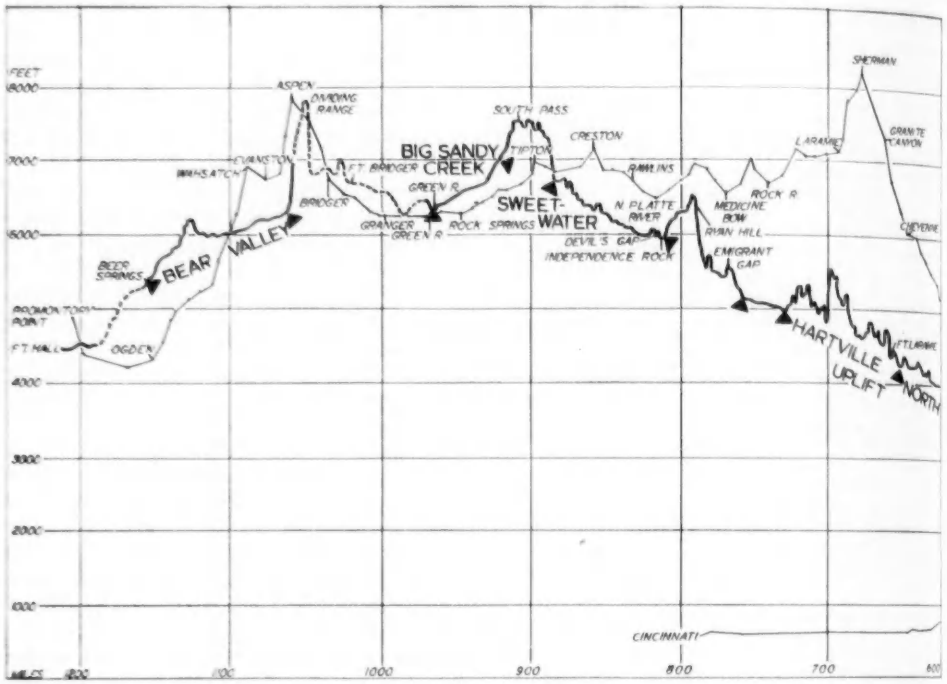

FIGURE 1

blank area in the American transportation map. In the 1840's even their terrain was a mystery which waited for nearly thirty years to be cleared up by Powell.

The exploration of the upper Missouri country withdrew the hope for an easy crossing in the north, and the awesome face of the Rockies in Colorado told travelers even at a distance that this was not the way. As has been shown, General Ashley had found, and even more important, had publicized, a passable way through the middle. Because this crossing bore the geographical relationship it did to those used by Lewis and Clark, it became the South Pass. Its character deserves careful analysis, not only because some misconception appears to exist as to its nature, but also because this became the classic natural route from which we may determine the relatively austere prerequisites for travel not assessed in terms of economic productivity.

"The discovery of South Pass, or the Great Gap of the Rocky Mountains, was one of the most important events in American history. . . ."[18] The broad nature of the pass is well known; Fremont reported its width as twenty miles when he traversed it in 1843. The gentle rise to it is also understood. But often it is conceived that South Pass is the main or single break in the central Rockies. Actually an earlier "South Pass" was found by Ashley a hundred miles to the north where the Wind River Range, whose foothills bordering the Great Divide Basin are breached by the ultimate South Pass, drops into a col before rising again as the Gros Ventre Range. This gap, Union Pass, was traversable by wagons, but its greater height (9,210 feet) and proximity to the snow pole of the Yellowstone Plateau made crossing possible for only a few weeks in late summer. To the south of South Pass, and divided from it by no more than the low and nearly buried granitic continuation of the Wind River Range called the Antelope Hills, is the broad expanse of the Great Divide

[18] Edmund W. Gilbert, *The Exploration of Western America* (Cambridge: Cambridge University Press, 1933), p. 140.

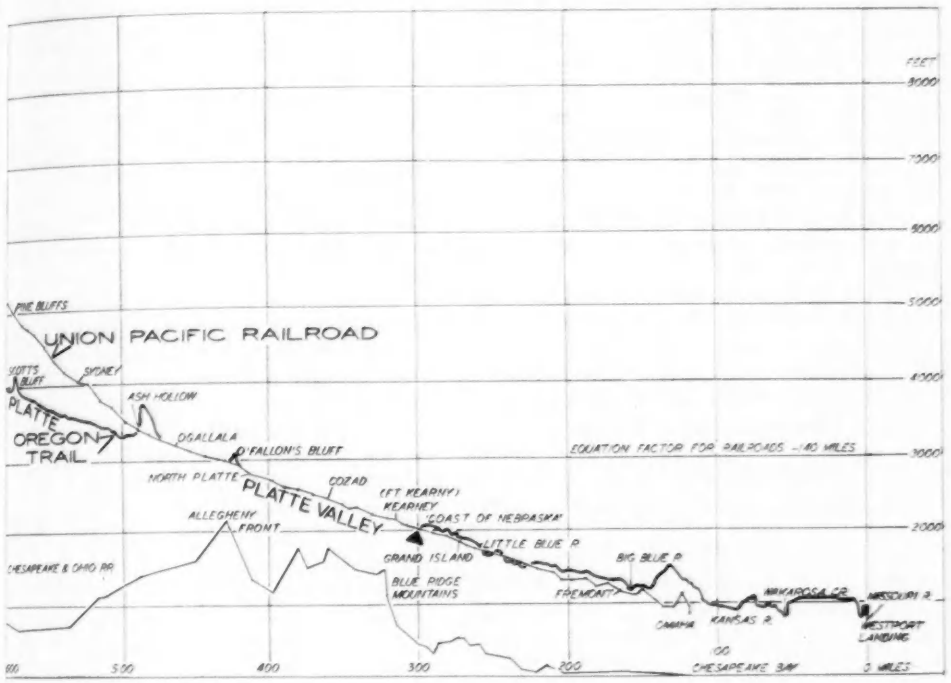

FIGURE 1 (Cont.)

Basin, a vast sag in the continental divide where much of the drainage is to the interior and where crossings can be made that are a thousand feet lower than those in the pass. At its narrowest, in the east between the Green and the Sierra Madre Mountains, this basin is seventy-five miles across. If South Pass is in any sense a gap, it is so in the sense of a shoulder of a much greater gap. This use of the slope rather than the floor must be explained, and the analysis of this diversion is, in summary form, the analysis of the peculiar requirements of the natural route.

THE ROUTE OF GRASS

Robert Stuart in 1812 was the first to follow the way that became the Oregon Trail. Moving eastward from the upper Snake River across the Green River Basin, his party passed through South Pass and attempted to turn southward into the heart of the Great Divide Basin, where they observed that the terrain was more level than along the latter-day trail. But Stuart wrote in his *Narratives*:

> seeing the channel [which they were following into the basin] of this stream turn due south without a drop of water running over its sandy bed, we quitted it without hesitation and steered E. N. E. for a wooded ravine.[19]

Thus they rejected the Great Divide Basin and returned to the trace of the later Oregon Trail. The heart of the basin had turned them back because of its aridity and absence of grass and fuel, not, it should be emphasized, because of its terrain.

An analysis of the many diaries and commentaries on the trail points up the over-riding importance of the natural endowments of the route, the least important of which was probably terrain. In at least two places (Ash Hollow in western Nebraska and parts of the toll road skirting the falls of the Columbia) primitive winches were used to lower wagons down very steep grades which might have been avoided had terrain alone been the locating agent. Grass, water, and wood dominate the chronicles, not mountains or Indians, both of

[19] Stuart, *op. cit.*, Narrative for Monday, 26th of October, 1812.

which could be conquered by the "company" organization introduced at the very beginning of the migration. The large company was seldom molested by Indians, so infrequently in fact that fictionalized histories must repeat mainly the experiences of small and badly organized parties. Moreover, in rough terrain the doubling of teams possible in a large company could overcome great obstacles.

But the traveler "beyond the frontier" was reduced to basically uneconomic travel. Recently Colin Clark has estimated that the economic limit for wagon transportation is 300 miles.[20] Beyond that distance travel becomes economically wasteful. Under these conditions, it was essential both on economic and practical grounds to depend on nature to provide support for the journey. Few of the pioneers could have afforded to pay for their provisions even if refit stations had existed. In the later years of the use of the trail this fact was borne out by the financial experience of the Pony Express and the haulage companies which found unsubsidized operation almost impossible. And only with ostensibly economic operation did it prove possible for them to abandon the Oregon Trail for the better alignment and greater safety of the Overland Trail, which developed in the late 1850's along the line that became for the most part that of the Union Pacific.

The dependence on nature was for the provision of a sustaining route. For this reason the Oregon Trail was in actuality not so much a terrain dominated way as a vegetation corridor in both a negative and a positive sense. Negatively, the trail avoided areas of heavy forest wherever possible. From Independence to the east base of the Rockies it was wholly grassland, and the gallery forest along the Platte, far from being a barrier, soon proved inadequate even for fuel for campfires. Once the mountains were reached, the lower tree line became a matter of concern. In Wyoming the lower limit of tree growth is seldom less than 6,000 feet, and in drier areas it is several thousand feet higher. The great gap in the mountains, represented by the Wyoming Basin, rules out significant orographic rainfall, thus raising the lower tree line. The break in the mountain totals of rainfall is as significant as the break through the ranges. Only at South Pass does the line of the trail rise high enough to approach, but not reach, the lower limit of forest. Once out of the South Pass, the trail entered desert country before reaching the *en échelon* ridges of the Wyoming, Salt River, and Aspen ranges, which nearly close the basin of the Green River on the west. But beside these linear masses the Bear River passed along a structural valley which gave access, in a rain shadow, to the dry Snake River plains. Thence to Oregon trees were far away from the route in the mountains to the north. The open forest of the Blue Mountains of Oregon posed little problem and only in the Cascades near the final objective did forest become a barrier. However, a toll road was soon cut through heavy timber on the south side of Mt. Hood to breach this single forest barrier. Thus, the absence of trees along the route between Independence and Oregon was as remarkable as the absence of heavy grades except at Ash Hollow and in the Cascades. Such an open track would have been impossible in Montana, where Mullan's Road was repeatedly closed by fallen trees toppled by winter snows, or in the wetter Colorado Rockies, which rise well above the lower tree line.

Related in part to the presence of a gap in the mountain forests in the Wyoming Basin is the fact that only here does the vegetation of the Great Plains reach to, and intermingle with, that of the Great Basin. Although many vegetation maps suggest that the Wyoming Basin falls within the Great Basin realm of sagebrush and scattered bunch grasses, careful field investigation shows that the rivers flowing into the North Platte are usually bordered by meadows of good grasses, several of which are Great Plains species that extend to the longitude of South Pass. The valley down which Robert Stuart turned after being rebuffed by the wastes of the basin in 1812 was the most important for western travel. But before discussing the Sweetwater which he thus discovered, it is necessary to return to the frontier of 1840.

In the tall grass areas of eastern Kansas and western Missouri, "In February and March thousands of wagons, and other vehicles, men and beasts were gathered about [Independence and St. Joseph, Missouri, and Leaven-

[20] Colin Clark, "Transport: The Maker and Breaker of Cities," *Town Planning Review*, Vol. XXVIII (1958), p. 239.

TABLE 1.—COMPUTATIONS OF MILEAGE AND TERRAIN

State	Miles of river route	Percent	Miles of upland route	Percent
Kansas	94	52	88	48
Nebraska	366	90	42	10
Wyoming	354	78	146	22
Total	814	75	276	25

Source: Charles Preuss, *Topographical Map of the Road from Missouri to Oregon, 1846*; scale of ten miles to the inch, Sections One through Five.

worth and Atchison, Kansas] waiting for the opening of spring which would bring favorable conditions for travel and sustenance for their 2,000-mile journey. With the coming of the first blades of grass, these trains in turn set forth."[21] The trail first passed along the divides between the Kansas and its tributary, the Big Blue, then turned northwestward across southern Nebraska to strike the Platte near Fort Kearny. For much of this distance, as Table 1 suggests, the course was away from the rivers. In the tall grass area the "prairie" was the source of feed and the river meadows were little used.[22] Although the swath of the trail was made obvious by mid-summer through closely cropped grass, it was possible here merely to move farther away at night and secure grazing. But once the Platte was reached, the contrast between the meadows and the range spreading without limit to the north and south was sharpened. Recuperation of grass was more rapid along the stream with its high water table, which also made water available on digging in the sand-choked bed even when the stream was low. The pioneers became river-bound, and only one river, the Platte, rises in the Rockies and reaches the Middle Border along the Missouri. The pioneers' view of the land is well summarized by the notations on vegetation on "the road map" of the Oregon Trail. As a result of Fremont's expedition of 1843, a map in seven parts was published by his topographer, Charles Preuss, and was widely used by the travelers. Table 2 summarizes Preuss' notations on grass. In light of present conditions we may question his assessment of the feed conditions in Section II, particularly the prevalence of sage, but that was the pioneers' information. Thus, in their minds the course from the Little Blue River of east central Nebraska to the Bear River valley in western Wyoming was one tied to the rivers for feed. In the summer season, when they crossed this area, water was to be found only in the larger streams and the seepage of water into the river gravels provided the ground water necessary for meadow grasses in the arid basins of the Rockies.

In this context, the Oregon Trail was tied first to the Platte from Fort Kearny westward to its forks, at present-day North Platte, Nebraska. At the forks of the Platte the migrants turned to this north branch because it carried them much farther to the west than the southern branch would have done. Stuart, Henry, Ashley, and the other Mountain Men had a generation before shown that the North Platte valley was the opening to the West along which pack trains could hope to find the natural endowments they required. It was not, however, without faults as a route. Just upstream from the junction with the Laramie River at Fort Laramie in eastern Wyoming the Platte cuts across a low spine of foothills jutting northeastward from the Laramie Range of the Rockies. This ridge, the Hartville Uplift of the geologists, constricts the North Platte in a narrow stream-filled gorge, which could not be traversed by wagons, forcing the trail to cross a dry upland for forty miles. Accounts of the trek make much of the privation beyond Fort Laramie as the oxen suffered from lack of water while mules suffered from lack of grass.[23] In this section it became common for the pioneers to begin the slow and painful jettisoning of unessential goods in order to lighten their wagons.

When the trail returned to the North Platte near Glenrock conditions improved, and the line of grass and water carried the migrants on, turning the northern end of the Laramie Range of the Rockies and entering the wide gate of the Great Divide Basin. As the route

[21] Charles Dawson, *Pioneer Tales of the Oregon Trail and of Jefferson County* [Nebraska] (Topeka: Crane and Company, 1912), p. 29.

[22] *Ibid.*, p. 109.

[23] There was a never-to-be-resolved argument whether oxen or mules were best on the trail. Oxen were highly dependent on good and plentiful water, but more able to do without feed than mules which demanded daily feed. Along the trail feed and water were usually found together, so both animals suffered at the same time. Leroy R. Hafen, *The Overland Mail, 1849–1869* (Cleveland: A. H. Clark Company, 1926), p. 310.

TABLE 2.—NOTATIONS OF GRASS CONDITIONS

Map section	Geographical limits	Comment on grass conditions
One	Westport Landing, Mo. to departure from Little Blue Valley, Nebraska 275 miles	"This section abounds with grass, water and fuel so that emigrants may encamp almost anywhere."
Two	Departure from Little Blue Valley to Lisco, Nebraska 225 miles	"With this section the prairie ends and the barren sage (artemisia) country begins."
Three	Lisco, Nebraska to Glenrock, Wyoming 234 miles	"Grass—is scanty and only occurs on the banks of the rivers and creeks."
Four	Glenrock, Wyoming to Green River Crossing, Wyoming 232 miles	"Grass is only to be found on the river banks and there sometimes very scarce."
Five	Green River Crossing, Wyoming to Fort Hall (Pocatello), Idaho 214 miles	"Between Green River and Bear River scarce afterwards good and plenty."

Source: Preuss, *op. cit.*

had lain along the right bank of the river from Ft. Kearny to the gate, it was necessary there to cross to the left bank in order to avoid being turned to the south by the bend of the river. At this fording place, which was later the site of a Mormon bridge at Fort Casper, it was necessary again to leave the river. The North Platte rises in the cul-de-sac of North Park in northern Colorado and flows northward for 200 miles, in the last quarter of this distance confined to the deep Fremont Canyon, before reaching Casper and swinging around the northern end of the Laramie Range. "The country, all the way from the crossing of the Platte, is dry, sterile, and dreary desert."[24] But after twenty-five miles of deadly water and no feed, the last important left bank tributary of the Platte, the Sweetwater, was reached just above its confluence with the main stream. Here stood the surpassing monument of the trail, Independence Rock, a granite remnant where frequently it was possible for travelers to celebrate Independence Day. In July, the Sweetwater valley deserved its name. The grass in its meadows was lush, the water was clear and plentiful, being fed by the snow fields of the Wind River Range, and the heat, flies, Indians, and cholera of the plains were mercifully in the travelers' wake. The granite hills bordering the valley were high enough to support thin forest, thus providing for campfires. And just ahead up a gentle gradient lay South Pass and the continental divide. For 125 miles running due westward this valley carried the pioneers in a state of plentiful provision around the desolate Great Divide Basin with its sand, rock, sagebrush, and alkali flats. To rise an extra 2,000 feet into an area nearly impassable in winter was of no concern in July, when, by that rise, feed and water were continued farther west than anywhere else south of impassable Montana. These were critical miles as each reduced the gap between the eastward and westward flowing rivers.

At South Pass the migrants had to face a break of fifty miles before reaching the headwaters of the Colorado in the Green River. Without exception the chronicles make this break in the rivers the worst part of the trail. Oxen died for lack of water and mules for lack of feed. If the gap had been more than fifty miles, for example the 200 miles of the Great Divide Basin, far fewer companies would have reached Oregon. Fifty miles could be covered without a stop, using the cool of the night to alleviate the toll. We easily forget that any desert crossing immediately introduces the economic measure in travel which may have avoided it up to that point. So long as nature provides, the "cost" can be forgotten. But in the desert the "cost" had to be carried in the wagons, and the distance limit fell with full force. Sometimes this limit was less than fifty miles, many teams and wagons were abandoned along dry Big Sandy Creek on the western slope of South Pass, and it is certain that

[24] Howard Stansbury, *An Expedition to the Great Salt Lake of Utah* (Philadelphia: Lippincott, Granbo and Company, 1852), p. 64.

the limit was seldom much over fifty miles, as the Cimarron desert on the Santa Fe Trail, which conquered even the legendary Jedediah Smith, reveals.

Although there were other dry stretches of the route to Oregon, none was so long or so completely dry as that between South Pass and the Green River. West of the Green River, it was generally possible to find water and grass for each evening stop. The divide between the main stream and its western tributary, Black's Fork of the Green River, was narrow, if desolate, and the pioneers reached Jim Bridger's Fort without trouble. This trading post, like Fort Laramie, had been established for fur trappers and they represented the only settlements between the Missouri frontier and the Columbia watershed when the trail came into use. From Bridger the trail crossed low divides between the Black's Fork and the Ham's Fork of the Green River to Little Muddy Creek and again between the latter and the Bear River. Along the Bear River, meadows were plentiful and trees were only on the slopes of the bordering Aspen and Bear River ranges. Bear River turns south to enter Salt Lake, so the trail had to turn northwestward across the southeastern plains of the Willow Creek lava plateau to reach Fort Hall (near Pocatello) and the main plateau area of southern Idaho. There the route was at last out of the mountains following along the Pacific rivers, and in an area where trading forts were more common. Not all the trials were over, but an analysis of the route beyond Fort Hall merely reinforces the conclusions drawn from the section to the east.

The travelers to Oregon had to set out from the Great Bend of the Missouri because that was the western frontier in 1840. Once having left that frontier they "were on their own," relying on nature to sustain them, which in truth meant that they had to be more concerned with feed for their animals than with any other aspect of the natural environment. No measure of cost needs to be applied, for this was basically non-economic travel. Only where nature was sterile did the economic measure begin to apply, because in those places the migrants had to transport the sustenance of travel as well as themselves. And no route could match the Oregon Trail for a combination of the negative virtues of grass rather than forest, hard unbroken terrian formed under semiarid conditions, and meager winter snows which would certainly be melted by the time the migrants arrived. On the positive side the connection, found only in the Wyoming Basin, of plains and Great Basin grassland cannot be overrated. That this fortuitous combination of natural endowments would have collapsed with year-round travel is unimportant for a migration way. That it was probably uneconomic to transport people and their small possessions overland to Oregon cannot be admitted. American destiny was never thought to be economically manifest, even in 1840.

THE UNION PACIFIC RAILROAD

The fact that it had proved possible to people the outlying frontier region of Oregon without regard for measures of cost, does not deny the related fact that once settlement in the West assumed considerable proportions, *economic* transportation had to be established. The population of the four Pacific Coast states, Washington, Oregon, California, and Nevada, increased from slightly more than 100,000 to more than 400,000 in the 1850's. Particularly after the region assumed true economic importance with the discovery of gold and silver, in California and Nevada, during this decade, the demand was great. The memorials to Congress, which represented the main contribution of the 1840's to the development of stronger ties with the East,[25] were followed at mid-century by more surveys of possible routes.

The first of these was the expedition led by Stansbury of the Topographical Engineers which was sent West in 1849 to survey the valley of Salt Lake, but reported additionally on the possibility of building a railroad across the Washakie Basin and along the Platte. He reported "a perfectly feasible, and indeed a most excellent route, whether for wagons or for railroad, has been traced, presenting fewer obstacles to the construction of either than almost any tract of the same length in the country."[26] This route, which will be discussed in greater detail, was that crossing into the Washakie Basin near Bridger's Pass on the

[25] See 29th Congress, 1st Session (Senate), July 31, 1846 for Asa Whitney's proposal for a Pacific railroad, which is usually considered the origin of the demand for a national undertaking to provide such ties.

[26] Stansbury, *op. cit.*, p. 242.

North Platte and leaving the Green River Basin through the upper Bear River Valley in southwestern Wyoming.

Congress in 1853 authorized a three-year program which produced six surveys on possible rail routes. Oddly, no survey was carried out along the Platte and through the Wyoming Basin, so Stansbury's report stood as the only material available. This may have been an advantage, as the late 1850's were a time when anything to do with the Territories became involved in the "slavery question." Jefferson Davis, who, as Secretary of War, had chosen the route surveyed along the 32nd parallel for construction, had to present a detailed defense of his selection. "This Senator (from Iowa) attributes to me the desire to secure a southern location for the interoceanic railroad on grounds of sectional advantage. I am confident that this location would be adopted by contractors who invested their own money in the enterprise; but that is a geographical opinion, not a political hope."[27] Until after the outbreak of the Civil War and the secession of the southern states no action could be taken. In 1863, a similar Pacific Railroad bill was introduced and adopted, leaving the choice of route and eastern terminus to Lincoln, as President. He specified that the construction would begin "near Omaha City, Nebraska," a point well north of even the Border States.[28] That this point of origin was dictated by strategic considerations during the Civil War seems borne out by the fact that no railroad across Iowa existed prior to the completion of the Union Pacific, and that during the construction period of the transcontinental railroad it was necessary to carry rails and other manufactured items west across northern Missouri on the Hannibal and St. Joseph R.R. to be trans-shipped by Missouri River boat to Omaha. In the long run the choice of the more northerly terminus proved advantageous as Chicago ultimately outdistanced St. Louis as a city and rail center. But when the Union Pacific was built, St. Louis was the metropolis of the West and the Missouri River the highway to the Plains.

Westward from Omaha there can be little question today why the particular route was chosen. The numerous publications required before government construction bonds could be issued, the reports of the chief engineer of the railroad which had to be printed, and the lengthy contributions of the government directors of the company leave us perhaps the most complete record available of the thinking that went behind the location of a railroad in an area without cities to determine its course. This record is one of the most illuminating documents of American transportation geography, particularly when it is compared with the nearly as full picture of the development of the Oregon Trail.

Haney wrote that there were two philosophies of railroad building—the British philosophy, which used a highly developed market to create an elaborate engineering structure, and the American, which used an austerity version of the railroad to create its own supporting market.[29] The British railway was the innovator in the form of transportation while the American railroad was the innovator in the use of transportation. Few, and then only relatively small, cities were created by the railway in Britain. West of the Mississippi Valley the majority of cities can be related directly to the building of railroads. Certainly part of the contrast in the influence of railroads is the stage of industrialization which witnessed their building. But also the contrast may be related to the difference in the alternative transportation in the two countries. In England, wagon transportation was *economically* possible even though the density of factories and shipments made wagon transportation *physically* impossible. In America, outside the old industrial areas of the Northeast, wagon transportation was economically impossible, for the distances were too great. And west of the Mississippi it is doubtful that any integration of quite local economies would

[27] "Speech of the Hon. Jefferson Davis of Mississippi on the Pacific Railroad Bill, delivered in the Senate of the United States, January, 1859," Baltimore: 1859, p. 17.

[28] Lincoln specified Sect. 10, Township 13 east, Range 15 west, an initial spot now in the middle of the Missouri River between Omaha and Council Bluffs. This location obligated the railroad to build the bridge across the Missouri River so that the Union Pacific has always had its terminus at Council Bluffs in western Iowa even though we normally think of its beginning in Omaha.

[29] Lewis H. Haney, *A Congressional History of Railways in the United States*, Bulletin of the University of Wisconsin, No. 211 (Economics and Political Science Series), Vol. 3, No. 2, pp. 197–198.

have been practicable before the much later development of the truck had not the railroad come along as a technical, and economic improvement, on wagon transport. It should be remembered that the Union Pacific built a thousand miles ahead of the market. In this context it was a classic example of the philosophy of railroad building of providing an economic connection between isolated areas of development.

The Union Pacific Railroad route (Fig. 2) for one-third its length is readily explicable. Although the developers argued about how to get out of the Missouri Valley into the loess country intervening between Omaha and the Platte at Fremont, Nebraska, the route was chosen mainly from the viewpoint of cost. By going a few miles south of Omaha, up a tributary creek valley and on to the level loess surface, money was saved at the expense of a steep grade. Only later when the market along the railroad had come into existence was this line relaid directly west through expensive cuttings in the rolling loess-covered country. Once on the Platte at Fremont, however, a river at grade provided an excellent and gentle rise directly to the mountains in the West. The only considerable obstacles to construction were the crossing of the Loup River, the securing of ties and railroad iron from the Missouri frontier, and the pilferage by Indians. Thus, the 291 miles of rail from Omaha to the forks of the Platte at North Platte was "determined" by the location of the eastern terminus at Omaha.[30]

At the forks of the Platte, General Grenville Dodge, who had been appointed Chief Engineer of the Union Pacific and was to find the best route across the Rockies, faced several alternatives of nature, and even more proposals. These may be summarized under three general classes: first, a crossing basically along the Oregon Trail; second, a series of crossings of the "Black Hills," or present-day Laramie Mountains, into the center of the Great Divide and Green River basins and thence to a joining with the trail at Fort Bridger; and third, the use of some pass across the Colorado Rockies westward from Denver. The last suggestion stemmed from the actual existence of a market in the gold workings around Denver developed after 1859. The reports of the railroad leave little doubt that the alignment would have been diverted through Denver had any practicable pass been found.[31] As an economic route the railroad was greatly concerned with on-line traffic, but the terrain required that Denver be served by a branch, which was soon built from Julesburg, Colorado up the south fork of the Platte.

Although many preliminary or reconnaissance surveys were run by the company engineers across the Laramie and Front ranges, none was ever carried along the Oregon Trail. The reasons for rejection of this route are, however, fully cited. "Impracticable cañons," diversion away from the river gradient by narrow and choked valleys (as in the Hartville Uplift), "a much larger amount of valuable timber contiguous" to a more southerly line, "snows [that] are reported much worse on the Sweetwater River than to the south of it," the large deposits of coal found in the Laramie Basin and Bitter Creek Valley of the Green River Basin, and the more direct route to the West found south of the trail, all appear to have weighted the choice in favor of the Wyoming Basin route.[32] Even though the locating engineer, Evans, concluded with respect to the trail route, "I do not mean to be understood that there is anything insurmountable here,"[33] he also expressed the view that it was not a good route for a railroad.

The characteristics of the country south of the Oregon Trail which led the engineers to favor building the railroad there may be presented briefly. Most important, at least most

[30] For a detailed discussion of the Omaha section of the line, see *Report of Thomas C. Durant, Vice-President of the Board of Directors* [of the Union Pacific Railroad], Omaha, 1864. The *Report* for 1865 discusses the location of the line in the Platte Valley.

[31] The investigation of passes west of Denver was thorough but highly disappointing. All lay well above 10,000 feet at their crests and were approached by steep grades from the east. It took nearly sixty years and great engineering works in the Moffat Tunnel before Denver finally secured a standard gauge east-west railroad in 1929.

A detailed discussion of the Colorado passes is given in U. P. R. R., *Annual Report for 1864*, Appendix B, and U. P. R. R., *Report of Gen. G. M. Dodge, Chief Engineer, on Lines Crossing the Rocky Mountains*, New York: 1867, pp. 2–33.

[32] A full discussion is contained in the *Annual Report of the Union Pacific Railroad for 1864*, pp. 22–23, and in Executive Document No. 13, House of Representatives, 40th Congress, 3rd Session, "Letter from the Secretary of Interior," p. 3.

[33] U. P. R. R., *Annual Report for 1864*, p. 23.

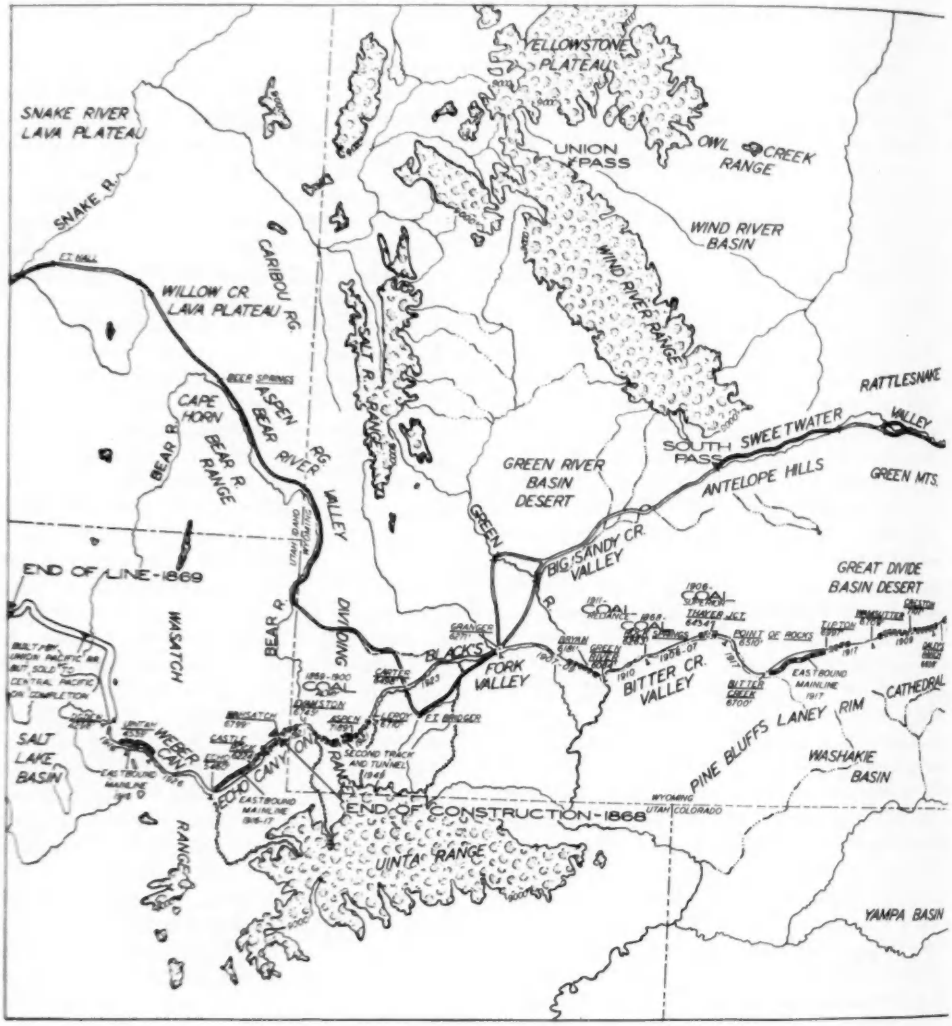

FIGURE 2

often cited, was greater directness. From the beginning it was stated that the trail route would be 70 miles longer between the forks of the Platte and Salt Lake than the route through the Great Divide Basin. Next perhaps was the greater snowfall of the Sweetwater-South Pass line. General Dodge stationed a party at the crest of the Laramie Range in the winter of 1866–67 to report on snow conditions. It was found that by keeping to the broad interfluves in the mountains the snow could be expected to be blown into the valleys leaving a fairly open track.[34] West of the Laramie

[34] U. P. R. R., *Chief Engineer's Report, 1866*, pp. 45–6. The open summits found around the Wyoming Basin, in contrast either with Colorado or Montana, made wind removal of snow an important factor in reducing winter blockages. Throughout its history the operating department of the railroad has encountered its greatest trouble with snow between Cheyenne on the east and Medicine Bow in the Laramie Basin, and even there mainly in cuttings or sections of track on the lee-side of open summits. Originally this problem was met by the building of snowsheds, but in the summer of 1949 these were replaced by massive snow-fences, which are fireproof.

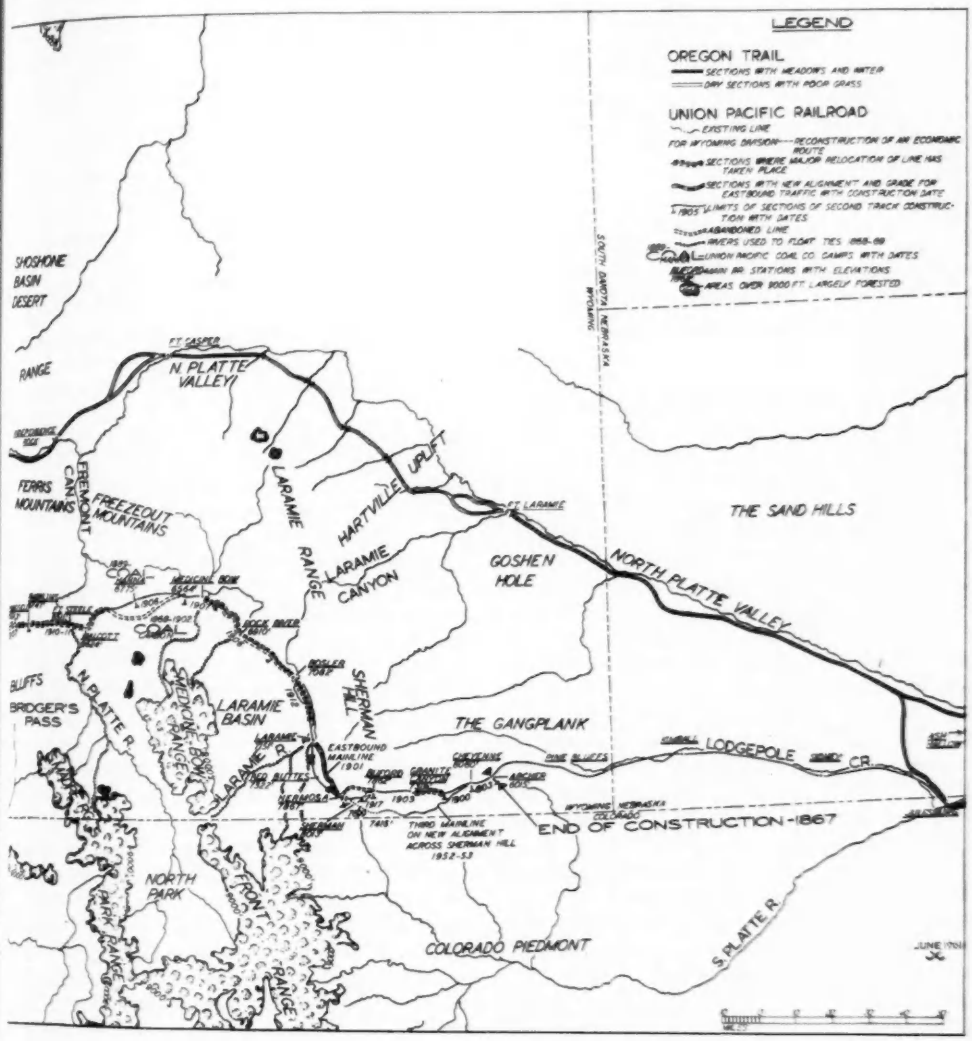

FIGURE 2 (Cont.)

Range, in the Laramie and Wyoming basins, the track was deliberately located on the east side of valleys with cuts oriented toward the west or northwest and embankments two to four feet higher than necessary in order to profit from the sweeping action of winds prevailing from the west and northwest.[35] Economic travel must be year-round, so the location of the railroad, unlike that of the trail, was influenced by winter conditions.

Throughout the building of the Union Pacific the concern for coal and timber was frequently expressed. As early as 1850, when Stansbury passed through the Wyoming Basin, coal was reported. During the building of the railroad a geologist was employed and his reports began to delineate the vast coal reserves of the area. Before the railroad was completed coal mines were opened at Rock Springs in

[35] U. P. R. R., *Chief Engineer's Report, 1868–9*, p. 4 for Rock Creek Valley, p. 38 for Echo Canyon in the Wasatch Mountains.

TABLE 3.—SOURCES OF WATER IN RAILROAD CROSSING OF THE WYOMING BASIN

Mile post (from Omaha)	Location	Sources of water	Depth of well	Character of water
711	Rawlins	Springs	–	Adequate for boilers[1]
724	Separation	Well	869 feet	"Brackish and alkali"[2]
752	Washakie	Well	no information	High lime and salt[1]
763	Red Desert	Well	no information	Moderately useful[1]
786	Bitter Creek	Dammed creek	–	Adequate for boilers[1]
795	Black Buttes	?	?	Moderate mineralization[1]
807	Point of Rocks	Well	700 feet	Moderate mineralization[1]
832	Rock Springs	Well	1,145 feet	Highly mineralized[1]
847	Green River	River	–	Good quality surface water[1]

Sources: [1] *Report of Chief Engineer, Union Pacific Railroad, 1868–'69*, p. 5. [2] *Williams Pacific Tourist and Guide*, 1881, pp. 93–99.

1868 and at Carbon shortly thereafter. Nearness to the northern spurs of the Colorado Rockies afforded the builders a source of ties. On the trail only at South Pass was railroad timber available, whereas on the line selected, ties could be cut in the Medicine Bow Range, the Uintas, and the Wasatch, Wyoming, and Salt River ranges in the west, and floated down short streams to the site of construction.

In water the Great Divide Basin route was inferior to that along the Sweetwater. Although there was little contrast between the two east of the Wyoming Basin (at Casper on the trail and Rawlins on the railroad), within the Basin severe disadvantages were found. Wells had been drilled along the railroad as it moved west from Laramie to the Green River. These were found to be highly subject to mineral salts. East of Rawlins substitute sources from the Laramie, Rock, Medicine Bow, and North Platte rivers could be secured. Thus, every river crossing became a watering point and Rawlins could receive piped water from the North Platte. West of there, however, the railroad faced 135 miles of poor water. Table 3 suggests how this situation was only partially overcome. The problem was not fully solved until the recent shift from stream to diesel-electric engines. West of the Green River its various right bank forks rising in the Wyoming and Uinta ranges could provide good boiler water.

If we accept that the Great Divide Basin offered a generally more desirable association of terrain, source of wood and coal, and directness than that along the trail, the problem of securing a practicable crossing of the Rockies still faced the railroad location engineers in 1866. It is a truism that any mountain chain will be crossed using tributary valleys which have carved a notch in the general crest of the range lowering the elevation to be overcome. It is less widely appreciated that the approach conditions to such a pass may be equally as important as its absolute height. In the case of railroads the chance of developing a "reasonable" grade is critical.[36] Consistent and reasonable grades were the great concerns of the developers of the Union Pacific.

Looking westward from the forks at North Platte, Nebraska, the engineers saw a gently sloping surface of the High Plains, for the most part undulating, but not deeply trenched by streams. This wedge of High Plains is bordered by the branches of the Platte and isolated from the Front Range by the longitudinal valleys of the Colorado Piedmont around Denver and Ft. Collins, and the Goshen Hole around Scotts Bluff, Nebraska. The location engineers followed up this inclined wedge, which Fenneman called "The Gangplank," toward the Laramie Range and were presented no difficulty in laying out a line with reasonable grades. Near the mountains, however, it was

[36] What constitutes a "reasonable" grade is far from a settled matter. On mainline railroads in the United States it probably would be around 2 percent at the highest, though several trunk routes have higher "ruling grades." Reasonable in this sense is an economic measure related to the total traffic, the average length and weight of trains, and the general type of locomotive used, as lightly traveled lines usually cannot bear the cost of heavy engineering works to overcome unfavorable grades. It is cheaper in that case to use more motive power for the light travel handled. This contrast between the use of extra motive power for light traffic and extra engineering for heavy traffic is well borne out by the reconstruction of the Union Pacific by the Harriman interests in the first decade of this century.

found that there is a longitudinal valley, representing in miniature and at a higher elevation, the "lowland" of Goshen Hole and the Colorado Piedmont. Although not deep or very wide, 200 feet and less than two miles, this depression was sufficient to make for a very steep climb to the crest of the range. In no place was it found practicable to build a line within the limits specified by the government grant, a rise of no more than 132 feet per mile, or 2.5 percent, without a long and costly summit tunnel.[37] Fortunately in the summer of 1865 James Evans found the key. His report bears quotation as it tells of a discovery important in American transportation geography.

> While making this examination of the eastern slope [of the Laramie Range] it became evident that if we could maintain our elevation, there was distance enough to carry us over, with reasonable grades. . . . The only difficulties seemed to be: First, carrying our line over the stratified rocks [High Plains structures] and on to the granite [core of the Laramie Range], as in almost every instance lateral ravines of considerable depth occurred when the formations came together. After running a number of trial lines, the divide between Lone Tree creek and the south branch of Crow creek was fixed upon as the one promising the best crossing, for the reason that there the connection between the sandstone and the older rocks was preserved by a neck of land forming a continuation of the divide, enabling us to reach the summit without undulating grades.[38]

From this we learn that in no more than one place, Granite Canyon, 20 miles west of Cheyenne, Wyoming, is there a physical connection between the gentle upslope of the High Plains and the decomposed granites with a rolling upland surface which form the Laramie Range. But that connection only several hundred yards wide was adequate to allow the railroad to be carried without loss in elevation into the mountains. There the High Plains reach their highest elevation, 7,300 feet, so that less than 1,000 had to be climbed to reach the summit at Sherman ten miles farther west. The repetition of the overlying sandstone strata on the west side again permitted the railroad to drop into the Laramie Basin with reasonable grades. Despite the fact that when built this was the highest stretch of railroad in the world, it was constructed with a ruling grade of 90 feet to the mile or 1.74 percent slope, better than the grade on the Pennsylvania Central in crossing the Allegheny Front at Altoona. In absolute elevation, of course, this summit was nearly a thousand feet higher than South Pass, and it could have been avoided by passing along the North Platte and into the Wyoming Basin north of the Laramie Range. The advantage of such a route would have been illusory, however, as the ruling grade would have been much steeper and the total rise greater because of redundant grades surmounted only to be lost. In economic travel it was correctly reasoned that it was the total rise over the whole route and its steepness in individual sections which determines the cost of transporting goods, not the absolute summit elevation.

West of the Laramie Range there were several secondary ridges to be crossed, but none proved difficult. The railroad had an undulating grade across the Laramie Basin with four minor summits to cross between the several tributaries of the Platte. Each could be surmounted with no greater slope than 0.82 percent, though the line as originally located was excessively curving and had to be considerably rebuilt around 1900. Reaching at the crossing of the North Platte a local low point almost 2,000 feet below the summit of the Laramie Range, the Union Pacific rose 600 feet over the low eastern edge of the Great Divide Basin and entered the dry wastes of the gap between the Colorado and Northern Rockies. This then was the area which the Oregon Trail had to avoid in its dependence on nature, but an area which the fixed and economically supported railroad could conquer. We have noted the provision of wells and water pipelines as well as the opening of coal mines. Except for the latter, however, the local environment merely allowed passage rather than provided patronage for the line. The high economic cost of this line had to be assessed against the financial return from other areas, and in this is revealed the way in which economic routes are able to utilize ways which would be denied to the migrant.

Once across the 135 miles of dry country between the North Platte and the Green River, the railroad was both across the continental divide and approaching an area where water, timber, and coal were available. Only at the western edge of the Green River Basin

[37] U. P. R. R., *Annual Report for 1864*, p. 4.
[38] U. P. R. R., *Chief Engineer's Report, 1866*, p. 33.

TABLE 4.—DISTANCES ALONG SEVERAL ALIGNMENTS BETWEEN OMAHA AND OGDEN

Alignment	Straight-line distance between termini in miles	Railroad distance between termini in miles	Percentage deviation
Omaha–No. Platte	255	291	14
No. Platte–Cheyenne	214	225	11
Cheyenne–Green R.	244	328	34
Green R.–Granger	25	30	20
Granger–Ogden	108	157	45
Total of legs via Cheyenne	846	1,031	22
Omaha–No. Platte	255	291 (actual)	14
No. Platte–Casper	315	358 (actual)	14
Casper–South Pass	137	175 (estim.)	28
South Pass–Granger	76	95 (estim.)	25
Granger–Ogden	108	157 (actual)	45
Total of legs via South Pass	891	1,076	21
Omaha–Ogden Airline	833	via Cheyenne 1,031	24
		via South Pass 1,076	29

Sources: Executive Document No. 15, 40th Congress, 3rd Session, pp. 7–8; The Official Guide of the Railways, November, 1957; World Aeronautical Charts, Nos. 305, 306, 307.

did terrain again pose a problem. In crossing from the Black's Fork of the Green River to the valley of the Bear River, a sharp ridge was encountered which necessitated grades of 90 feet per mile. These were later reduced by tunnels at Aspen when the volume of traffic warranted the capital cost. In the upper Bear River drainage coal was found near Evanston at Almy. The main concern then was whether grades or distance should determine the route to be followed to the Salt Lake Valley. The Bear River might be followed along its gently sloping valley for 225 miles to the northern arm of the lake. But such a route was very circuitous, carrying the projected line completely around the northern spur of the Wasatch Range, Cape Horn, at Beer or Soda Springs, Idaho. Or the summit of the Wasatch might be crossed only 50 feet above Evanston and ten miles west of the town. This route, however, would lead the railroad into the tortuous Echo and Weber canyons, which could be breached only with a number of short tunnels and much blasting. The much shorter distance, 62 miles, determined the choice of the crossing of the Wasatch directly. For fifty of these miles there was an unbroken downgrade totaling exactly 2,500 feet, which allowed the route to be built within the limits of 90 feet per mile.

THE NATURE OF THE ECONOMIC ROUTE

The critical tests to be applied to a railroad route have been mentioned: distance, directness, total grade, opposing grade, steepness of grade, and irreducible grade. With the exception of directness, all of these are most desirably held to a minimum, but no line can be perfect and the degree of departure from a base figure is a test of the economic costs of transportation which may be assigned to the geographical conditions of the route. In such analysis it is necessary to exclude a consideration of the efficiency of operation of the railroad company, its wisdom in choosing motive power, its abilities in securing patronage, and the other human aspects of railroading. It seems that all too often the geography of transportation has been preoccupied with the areally oriented history of the way men ran railroads. Of greater import are the exactions of geography in the provision and cost of transportation. The Union Pacific is an exceptionally interesting example because at the time of construction the absence of on-line markets allowed the builders to restrict their concern to physical features.

The airline distance between Omaha and Ogden is 833 miles. This can be taken as the base for any discussion of the directness of the Union Pacific as events early established these as the termini of the railroad. Table 4 presents a summary of the length of the various "legs" that any route might contain using first the line through the Great Divide Basin, and secondly that through South Pass. For the reasons discussed previously, there were certain critical points along either line which

TABLE 5.—EXTENT AND DIRECTION OF GRADIENT AND TOTAL ASCENT AND DESCENT

Sector	Miles of ascent	Miles of descent	Total ascent in feet	Total descent in feet	Net rise or fall	Level miles
1st 100	61.40	8.37	797	289	508 feet	30.32
2nd 100	73.49	5.53	745	60	685 feet (1,193′)	20.99
3rd 100	71.59	8.99	790	103	687 feet (1,880′)	19.43
4th 100	77.42	10.16	1,128	130	998 feet (2,878′)	12.43
5th 100	80.62	4.76	1,823	101	1,722 feet (4,600′)	14.63
6th 100	49.74	33.86	2,748	1,398	1,350 feet (5,950′)	16.40
7th 100	29.50	55.80	952	1,496	–544 feet (5,406′)	15.70
8th 100	38.55	45.30	1,293	1,272	21 feet (5,427′)	16.15
9th 100	35.07	35.33	840	969	–129 feet (5,298′)	29.60
10th 100	36.72	52.79	1,196	2,373	–1,177 feet (4,121′)	10.49
11th 100 (86)	26.20	45.26	775	1,146	–371 feet (3,750′)	14.33

Source: Table, "Grades of Union Pacific Railroad," Union Pacific Railroad, *Report of Chief Engineer, 1868–'69*, p. 28.

must be passed through, so that any discussion revolves around the directness between these individual pairs of points and the composite of the airline distances carried through these critical points. It may be observed that the line as laid out was 1,031 miles, or 198 miles greater than the airline distance between Omaha and Ogden. If, however, we introduce the sum of the "legs" this distance is only fractionally increased, from 833 miles to 846 miles. The Great Divide Basin route, as built, was 24 percent above the base. Turning to the South Pass line, whose probable route we can only conjecture as railroads even today parallel only part of the Oregon Trail, we find that the sum of the "legs" is 891 miles and the postulated rail distance would be around 1,076 miles, an increase of distance of 29 percent. Certainly on the basis of directness between Omaha and Ogden the Great Divide Basin route had much to recommend it. In addition, it is remarkably direct for a route crossing the Rockies and running for over 440 miles above 6,000 feet elevation (Archer, Wyoming to Emory, Utah).

The characteristics of the grade of the original line of the Union Pacific are shown in Table 5 from information drawn from the final construction report of the Chief Engineer of the railroad. There are five distinct sections of the line in the matter of grade, for which field checking has established the points of division. The first section from Omaha to the east base of the Rockies at Granite Canyon, a distance of 536 miles, is a singular route. Except for the poorly located alignment at Omaha, the railroad rose gradually for over five hundred miles. In this distance there were approximately 103 miles of level track, 396 miles of ascending line, and 37 miles of downgrade (respectively 19, 74, and 7 percent of the distance). The rise was 6,332 feet, secured at the expense of intermediate descents not exceeding 683 feet, or what might be called a ratio of efficiency in rise of 90.2 percent.[39] That such a high ratio of efficiency could be attained for half the length of the railroad, attests to the fact that the railroad was laid out primarily in relation to terrain. The ratio for the Oregon Trail from Independence to Fort Hall is 33.1 percent, reflecting the relationship to vegetation and water rather than terrain.

The line through the Laramie Range (miles 536 to 564, Granite Canyon to Red Buttes, Wyoming) was built on heavy grades, which were impossible to avoid. Even here, only 6.5 miles were at 90 feet per mile (1.74 percent) with the remaining 21.5 miles at a lower grade. The difference in elevation between the east edge of the mountains at Granite Canyon (7,316 feet) and the west edge at Red Buttes (7,322 feet) is nominal, so that the elevation at the summit, 8,235 feet, is a thousand feet above either base. Drawings of the original line, since replaced and abandoned in its highest part, are no longer available, so that it is necessary to substitute an analysis of

[39] This ratio is determined by the following formula: $ER = \frac{TC}{TR + TD} \times 100$ where ER is the efficiency ratio, TR the total rise, TD the total downgrade, and TC the absolute difference between termini, or critical points, in elevation. The result gives a measure of the effectiveness of rise or descent in overcoming an irreducible change in grade.

the replacement line opened in 1903. This route has a slightly lower summit, 8,013 feet, a generally less steep grade, and a short summit tunnel. Under these conditions we find 13.5 miles of upgrade and 14.5 miles of downgrade. The efficiency ratio between Granite Canyon and the summit at Sherman is 100 percent, but for the whole distance to Red Buttes drops to 90.9 percent because of a small redundant grade east of the Hermosa Tunnel.

The third section, 375 miles, between Red Buttes and Aspen, Wyoming, was broken terrain with a number of low divides between separate drainage areas in the Laramie, Great Divide, and Green River basins. At Red Buttes the elevation was 7,322 and at Aspen 7,227 feet. The rolling grade between the two had at least 26 "summits" of which 17 were less than 100 feet high. On the major divides there were several rises of 150 to 350 feet and the last pull up to the divide between the Green River and Bear River drainage was exactly 900 feet. The total rise for this 375 miles was 3,428 feet, whereas the total descent was 3,470 feet. In this distance there are several critical points, the crossings of the North Platte and Green rivers, where local low points of 6,498 and 6,081 feet respectively are found, and the rims of the Great Divide Basin, Creston and Tipton, 7,107 and 7,002 feet, where heights are encountered. A perfectly graded course through these points between Red Buttes and Aspen would require ascending and descending grades of 3,605 feet. The actual line has grades totaling 6,898 feet, which gives an efficiency ratio of 52.2 percent. If more critical points were admitted to the calculation, the ratio would of course rise.

The fourth section of the line, Aspen, Wyoming to Ogden, Utah, was 90 miles long, comprising a short stretch of rolling upland in the east and then a long unbroken downgrade into Ogden. Aspen at 7,230 feet and Ogden at 4,298 feet are the critical points. The total rising grade is 129 feet, the descending grade is 3,052 feet, and all grades equal 3,181 feet. The irreducible change in elevation between Aspen and Ogden is 2,938 feet, so that the efficiency ratio stands at 92.1.

Thus, for the four sections of the Union Pacific between Omaha and Ogden the grade efficiency ratio is: I = 90.2, II = 90.9, III = 52.2, IV = 92.1. These ratios demonstrate the remarkable overall efficiency which can be secured when a line is laid out strictly in relation to terrain, even in very mountainous country. An apt comparison to this standard is provided by the analysis of one of the major railroads crossing the Appalachians in the eastern United States. There the Chesapeake and Ohio Railroad is considered both an efficient and profitable carrier. In the 666 miles of the line between Virginia tidewater and Cincinnati, the C & O has an irreducible summit on the Allegheny Front of 2,065 feet but a total rise of 3,480 feet, 169 percent of the summit elevation. The efficiency ratio for this line is 55.9, which shows that the high ratios found along the Union Pacific are truly remarkable for a line crossing the Rockies.

In considering the other aspects of grade—opposing grade, steepness, and redundant grade—it is necessary to draw one very sharp distinction between the railroad and the trail. Established as a route to the frontier, the trail can be analyzed in one direction only, that westward from Independence. There was relatively little eastward movement over the migration route, largely because of the economic toll discussed above. Thus, the eastward working of the trail is unimportant. But the railroad had to be a two-way route, not only because of its economic nature, which was certainly to connect the West with the East as much as in the reverse direction, but also because the equipment had to pass in round trips on the line to make it economically viable. Wagons might be demolished on reaching Oregon, but locomotives could hardly suffer this fate. For the railroad we must consider opposing grade and its steepness in two directions, so comparisons with the trail can only be carried out in relation to the westbound character of the railroad.

Even the railroad seems at first to have been a "westbound" route. Much of the reconstruction of the Union Pacific during this century has been to secure a better "eastbound" route, as is shown by the construction of eastbound mainlines at Uintah and Echo, Utah, and at Bitter Creek and Laramie, Wyoming.

Table 6 summarizes the extent and direction of gradient on the Union Pacific as completed in 1869, based on mileage increments west from Omaha. Over half (53.4 percent) of the distance westward was in ascending

TABLE 6.—GRADIENT OF THE ORIGINAL UNION PACIFIC RAILROAD, BY MILEAGE AND TERRAIN

Sector	Geographical limits	Terrain	Level	Miles of grade				
				0 to 20	20 to 40	40 to 60	60 to 80	80 to 90
1st 100 miles	Omaha to near Columbus, Nebraska	Platte Valley	30.32	53.52	12.67	–	3.58	–
2nd 100 miles	Columbus to near Kearney, Nebraska	Platte Valley	20.99	71.57	7.45	–	–	–
3rd 100 miles	Kearney to near North Platte, Nebraska	Platte Valley	19.43	70.10	10.48	–	–	–
4th 100 miles	North Platte to near Sydney, Nebraska	High Plains	12.43	62.50	25.08	–	–	–
5th 100 miles	Sydney to Archer, Wyoming	High Plains	14.63	25.29	60.09	–	–	–
6th 100 miles	Archer to Cooper Lake, Wyoming	Laramie Mts. and approaches	16.40	15.09	25.18	9.03	27.90	6.40
7th 100 miles	Cooper Lake to No. Platte Bridge, Wyoming	Laramie Basin and Rattlesnake Range	15.70	26.22	22.20	23.50	2.38	–
8th 100 miles	North Platte Bridge to Bitter Creek	Continental Divide Basin	16.15	34.22	21.04	28.59	–	–
9th 100 miles	Bitter Creek to Carter, Wyoming	Green River Basin	29.60	33.81	20.45	16.14	–	–
10th 100 miles	Carter to Echo Summit, Utah	Eastern approach to Wasatch	10.49	15.67	36.13	18.66	13.25	5.80
11th 100 miles (86 miles)	Echo Summit to Promontory Point	Weber Canyon and Salt Lake Valley	14.38	33.21	23.96	2.64	9.36	2.29
			200.52	441.20	264.73	98.56	56.47	14.49
				50.4%	30.2%	11.2%	6.4%	1.6%

Source: "Grades of Union Pacific Railroad," *op. cit.*

grades, which totaled 13,087 feet. The line dropped to the west for a little more than a quarter of the distance (28.1 percent) and was level for 18.4 percent of the line. The ascending and descending mileage figures are, of course, reversed for easterly travel. More significant than the amount of rise and fall is the degree of steepness it introduces. The 875 miles of grade are mainly in the class of light rises and falls in the line. Half the grades are under 20 feet per mile and over 80 percent are in the group below 40 feet per mile. Except for the poor location at Omaha, all the stiff grades are concentrated in the crossing of the Laramie Range and the Wasatch Range. Westbound, only the first of these was any problem as the grade in the Wasatch opposed only eastward traffic. These were economically important facts as they allowed the company to concentrate "helper" engines in these two places. With two-directional flow, the Laramie Range summit, generally referred to as Sherman Hill, was the more considerable barrier affecting both directions. Recently, in 1952–53, the Union Pacific constructed a "by-pass" around Sherman Hill which largely removed this barrier. At a cost of $18,000,000, a line was constructed with a ruling grade of 43 feet per mile in what was the largest railroad project undertaken in this country for many decades. Similarly, in 1923 an eastbound mainline laid out in Weber Canyon above Ogden reduced the grade to 60 feet per mile. The completion of these two projects allowed the Union Pacific to operate with no grade above 60 feet per mile throughout its entire length. Such reconstruction demonstrates the effect of traffic development on railroads which started out as what Haney called "American-type" lines.

A final measure of the geographical characteristics of routes, the concept of redundant grade, is tied to the matter of the irreducible heights to be overcome. Any way must be controlled by major terrain features. To cross the continent it is necessary to cross the Rockies. Thus, there are certain irreducible elevations which must be overcome. On the Oregon Trail, for the reasons discussed, South Pass at 7,550 feet was the irreducible elevation, just as for the Union Pacific this was Sherman Hill, 8,235 feet in the first line. If we use Independence, Missouri as the base point, at 740 feet,

the necessary rise to South Pass is 6,800 feet, and the comparable figure for Sherman Hill is 7,500 feet. Using the profiles in Figure 2, it is evident that the Oregon Trail, considering only major rises, had to overcome at a minimum 19,000 feet of elevation in reaching the summit of South Pass. From the same figure it appears that a route from Independence to Sherman Hill summit, measured along existing railroads, would have overcome 12,236 feet. For South Pass the excess rise over the irreducible height, or the redundant grade, is 12,200 feet. The ratio of irreducible height to grade encountered is 1:2.8. The ratio for Sherman Hill, the measure of redundant grade, is only 1:1.6. This rather than any other factor explains the abandonment of South Pass by the railroad, for which the cost of operation was the critical feature. For the trail the only valid "cost" figure was success in reaching Oregon, and for that grass and water were the measures rather than redundant grade.

Finally, it should be noted that the *economic route* is constantly subject to improvement in order to secure a better financial return from the providing of transportation. Figure 2 summarizes the continuing reconstruction of the Union Pacific Railroad. Between 1900 and 1917 the line was double-tracked as far as Granger, Wyoming and the branching of the Oregon Short Line Railroad. And the line to Ogden was doubled by 1926. The construction of separate eastbound mainlines has been noted. The program of relocating the original line so as to secure a more profitably worked railroad has been going on for sixty years. The bad and curving alignment north of Laramie was noted at the time of construction and was largely replaced soon after 1900. Again, in the Great Divide Basin and Wasatch Range sections of the railroad the continuing high operating costs brought by the cheap initial construction were so great as to require rebuilding. The "by-pass" of Sherman Hill was carried out in 1952–53 and a new line between Rawlins and Daley's Ranch was finished in 1953 in order to improve the grades over the saddle between the North Platte and Great Divide Basin. It may be said in conclusion that only the "naturally graded" sections of the original line remain. Wherever a physical barrier was encountered the expediency of the American type construction of the original line has had to be bettered. With the developed market has gone the money to build better, and in relation to current needs. Unlike the trail, the railroad has had no unique historical part to play.

CONCLUSIONS

Transportation has two distinct aspects shown by characteristics of *location* and *use*. The comparison of the Oregon Trail and the Union Pacific Railroad, which are broadly parallel in location for a thousand miles, brings out the importance of this distinction. Although it is commonly assumed that the trail was located where it was because of the gap in the mountains at South Pass, this assumption does not seem justified by contemporary accounts of the creation of this route of migration. Instead, grass and water, open route in summer and the absence of forest, and the unique almost unbroken line of grassland linking the Missouri Frontier with its isolated offshoot in the Willamette Valley seem to explain the choice of the way. Terrain seems to have played only an indirect role, through its influence on vegetation and water. The Oregon Trail was located where nature came closest to maintaining the traveler rather than where effort was least.

The location of the Union Pacific fits our concept of terrain domination much more fully. Its line was the line of least wasted effort, a situation we might logically anticipate in a route constructed for economic operation. This is not the same as saying it was the line of lowest summits, because the lowest summit may entail more effort than one approachable with the minimum redundant grade. The Oregon Trail was abandoned because it was based on entirely different location factors, factors which no longer had importance.

The waning of importance of the trail's location factors came from a shift in use of the route. The objective of the trail was to secure a simple, unvalued movement of people from one place to another. Its cost had two polar items, success or failure, between which there were no intermediate classes. And success in passage had to be found in each part of the trail with no chance of recouping local failure by some distant success. The result was that the route was made up of a string of sections each of which provided at

least the bare essentials of support except between South Pass and the Green River. The fitting together of these parts into a continuous route was the main concern of the pathfinders of the Oregon Trail. Once the parts fell together, the trail was immediately usable and, during the forty years of use, remained little changed.

The use of the railroad, on the other hand, was basically to provide a continuing connection that could be operated at a cost which would encourage use and yield a profit. There was nothing unique about its alignment. With the ability to equate losses from one section against the profits from another section, the road could be built and operated in a number of ways. But obviously certain combinations of parts would yield the highest profit and, in an area without intermediate markets, profits were largely determined by the length and opposing grade of the line. When built, between 1865 and 1869, the expected profits could not justify either expensive grade reduction or line shortening. Subsequent development has justified these undertakings. With increased profitability in economic transportation, change has taken place and the Union Pacific has been rebuilt. This reconstruction, however, clearly indicates the continuing use of this route as a bridge across country of low productivity. All relocation and rebuilding of the line has been determined by the desire to lower the cost of providing through transportation, not in any instance to tap on-line markets. It is obvious in the case of both the trail and the railroad that location is determined by the use made of the route.

GROWTH OF INDIVIDUAL METROPOLITAN AREAS: A GLOBAL VIEW[1]

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THIS report of growth rates for 906 of the world's Metropolitan Areas (M.A.'s) is intended to provide scholars with data for use in research and to indicate some outstanding features of the world-wide growth of cities. Attention is first directed to certain problems in the study of urban growth. Attempts to cope with these problems in the present research are then described, followed by observations on the limitations of the M.A. growth rates which appear in the Appendix.[2] The paper concludes with an analysis of regional and global patterns in the growth rates.

MAJOR PROBLEMS IN THE STUDY OF THE GROWTH OF CITIES

Despite the recognized importance of urbanization,[3] population growth in individual cities,[4] and the size of cities,[5] adequate explanatory generalizations concerning the growth of urban centers have yet to be advanced. Two conditions have worked against the formulation of such generalizations. For one thing, the study of the growth of cities has been restricted largely to individual countries[6] and, as a consequence, there has been little basis for seeking universally valid explanations. Some hypotheses do exist, but they are dubious because they rest on observations in a few nations constituting a biased global sample (with an extreme over-representation of industrialized societies).

Moreover, in addition to the limited scope of past studies, the comparability of their data has always been subject to question. For a comparison of urban growth rates to be valid there must be assurance that: (1) the boundary of each city closely corresponds to the actual extent of urban territory and (2) the boundary of each city shifts over the growth period in accordance with the expansion of urban territory. Since most studies of urban growth rely on census data and since census data are typically reported only for governmental divisions, rates of urban population increase are often based on political boundaries, although these boundaries may bear little correspondence to the actual limits of urban territory.[7]

The effect of differences in city boundaries on the comparability of growth rates was recognized by an early student of urban phenomena, Paul Meuriot.

> . . . any truly scientific study of urban agglomerations thus presupposes the liaison between the city and its suburbs. If one rejects this postulate, one falls fatally into the grossest errors. A striking example of this is furnished us by the two metropolises

[1] The research reported in this paper was carried out under the auspices of International Urban Research, University of California, Berkeley.

[2] All growth rates appearing in the Appendix are based on average annual percent increase in the population. The formula employed in their computation is shown on the first page of the Appendix.

[3] See, e.g., Kingsley Davis and Hilda Hertz Golden, "Urbanization and the Development of Pre-Industrial Areas," *Economic Development and Cultural Change*, Vol. III (1954), pp. 6–26.

[4] See, e.g., Victor Roterus, "Effects of Population Growth and Non-Growth on the Well-Being of Cities," *American Sociological Review*, Vol. 11 (1946), pp. 90–97.

[5] See, e.g., Colin Clark, "The Economic Functions of A City in Relation To Its Size," *Econometrica*, Vol. 13 (1945), pp. 97–113.

[6] See, e.g., Donald J. Bogue, *Population Growth in Standard Metropolitan Areas, 1900–1950, With an Explanatory Analysis of Urbanized Areas* (Washington, D.C.: U. S. Housing and Home Finance Agency, 1953). There have been remarkably few systematic and truly international studies of the growth of individual cities. In the U. S., for example, one can point only to Adna Ferrin Weber, *The Growth of Cities in the Nineteenth Century: A Study in Statistics* (New York: Macmillan, 1899).

[7] The findings of a recent study indicate that data on political cities, if carefully selected and used with caution, do provide fairly reliable indices of urbanization; see Jack P. Gibbs and Kingsley Davis, "Conventional Versus Metropolitan Data in the International Study of Urbanization," *American Sociological Review*, Vol. 23 (1958), pp. 504–514. Nevertheless, there are numerous instances of a marked discrepancy between the political limits of a city and its demographic, ecological, and/or economic boundaries; see International Urban Research, *The World's Metropolitan Areas* (Berkeley and Los Angeles: University of California Press, 1959), pp. 6–9. The adequacy of census data on urban centers has been much improved in various countries by the delimitation of non-political urban boundaries (i.e., urbanized areas, agglomerations, conurbations, or standard metropolitan areas); but such delimitations have not yet solved the problem of international comparability, since different delimitation criteria may be employed in each country.

of Central Europe, Berlin and Vienna. From 1900 to 1910 the population of the Austrian capital increased 356,000, growing from 1,674,000 to 2,030,000. During the same period the German capital increased from 1,888,000 to 2,070,000; it grew only 182,000. This suggests that Vienna grew twice as much as Berlin; but this is only the appearance. The territorial extent of Berlin is only 6,300 hectares; that of Vienna is 17,000, nearly three times as large. Thus, Vienna, properly speaking, has no suburbs outside of its administrative boundaries; its growth takes place within the city limits, as does that of all cities with very extensive areas. In the case of Berlin, however, the equivalents to the suburbs of Vienna are outside the administrative limits of the city. If one adds to the territorial extent of Berlin that of the immediately adjoining suburbs, the total area equals that of Vienna. Now within these revised limits, the growth of the Berlin agglomeration is more than double that of Vienna. The population of this complex grew from 2,460,000 in 1900 to 3,215,000 in 1910, an increase of 755,000 as compared to 356,000 for Vienna. Berlin's increase in just the 1905–1910 period, 357,000, was equal to that of Vienna for 1900–1910.[8]

Meuriot's observation indicates how the nature of administrative limits may influence the amount of population increase. Consider, also, an illustration of the influence of change in administrative limits. In 1947 the population of Sydney municipality (Australia) was 95,925; and seven years later it was 193,103, an increase of over 100 percent. This phenomenal increase is misleading, however, since the limits of the municipality were expanded to incorporate territory which was urbanized long before 1947.[9] Sydney municipality is an unusual case, but it demonstrates that there is no necessity for the administrative limits of a city to shift in accordance with expansion of urbanized territory. The limits may remain fixed while the urbanized territory expands; they may be extended far beyond the urbanized territory; they may contract while the urbanized territory either remains stable or expands; or they may expand so as to incorporate territory urbanized before the growth period. In short, urban growth rates based on political boundaries are always suspect.

[8] "De la Mesure des Agglomérations Urbainese," *Bulletin de l'Institut International de Statistique*, Vol. 19, No. 1, Part 2 (1911), pp. 1958–1959.

[9] Sources: 1947 and 1954 census reports of Australia. Fortunately, these reports provide data on metropolitan Sydney, which in 1954 contained some nine times as many inhabitants as did the municipality.

SOLUTION OF THE MAJOR PROBLEMS

With the world-wide delimitation of Metropolitan Areas by International Urban Research the problem of boundaries in the study of urban growth has been substantially lessened, since these units (M.A.'s) are far more comparable (in demographic, ecological, and economic terms) than political cities.

Since the procedure followed in the delimitation of Metropolitan Areas is set forth at length in another publication,[10] we shall consider it only briefly. The delimitations in each country began with a list of all administratively defined cities, or continuous urban areas, of 50,000 or more, designating them as principal cities. Then the administrative divisions around these cities were examined to determine the percentage of their labor force engaged in agriculture and their distance from the principal city. To be included in a Metropolitan Area, an administrative division had to: (1) touch upon the principal city or another division already included in the M.A.; (2) have at least 65 percent of its labor force engaged in nonagricultural occupations; and (3) be located close enough to the principal city to make commuting feasible. In some cases the lack of data made it necessary to substitute a density criterion for the nonagricultural standard, in which case any unit included in the M.A. had to have a density either equal to half or more of the density of the principal city (or inner ring) or twice that of the next outer ring. If the boundary of the area established by these criteria failed to include at least 100,000 people, it was dropped from the list.

One major problem in the study of urban growth is obtaining data which are globally representative. Rather than attempt to achieve representativeness through sampling procedures, the present research aimed for complete coverage. This goal was not realized, but it proved possible to compute growth rates for 906, or 85 percent, of 1,064 urban centers which qualified as Metropolitan Areas at about the middle of this century.[11] These 906 places are located in 82, or 78 percent, of

[10] *The World's Metropolitan Areas.*

[11] Reports of the 1959 U.S.S.R. census have increased the world total of M.A.'s and cities of over 100,000 population beyond the number reported in *The World's Metropolitan Areas.*

the 105 countries and territories that have at least one M.A. The 23 countries and territories excluded because of insufficient data are listed in the preface to the Appendix. These 23 countries and territories are a highly select group, with a low degree of industrialization being evident. Note, however, that this bias in exclusion is lessened in two ways. First, the M.A.'s in the 23 excluded countries and territories account for only 13 percent of the world's metropolitan population.[12] And, second, several countries and territories characterized by a low degree of industrialization are included in the study, which means that we are not left entirely ignorant as to the growth of M.A.'s in such parts of the world.

It is unfortunate that certain countries in which urban expansion may exhibit unusual qualities are not included, and this is particularly true in the case of mainland China. Thus, the data in the Appendix do not represent complete global coverage (which, under present conditions, is an impossibility); but they do represent the most complete coverage to date.

LIMITATIONS OF THE GROWTH DATA

In addition to completeness in coverage, there are questions concerning the reliability of the data in the Appendix. The first, and perhaps most crucial, question pertains to the validity of the metropolitan boundaries. Since the delimitation method was designed for global application, it had to be both general and simple. As a consequence, it cannot take into account the features of a locality that are not revealed in census reports. Such features may be revealed through a field investigation or first-hand experience, and thereby be taken into account, but only a general delimitation method based on census data is feasible for global application. Nevertheless, an assessment of the validity of the delimitations must await a comparison of the results with those achieved in detailed studies of particular metropolitan localities. But agreement in results is relative to the type of boundary in question. The population reported for a Metropolitan Area may not agree with that reported for the urban area in the same locality—precisely because the metropolitan limits may not correspond with those of the urban area. All that can be said for the M.A. delimitations is that there is no evidence that they contain a bias, i.e., the boundaries are not consistently unrealistic in any particular way, nor are they more realistic in certain types of countries than in others.

We have noted that the 906 urban centers listed in the Appendix all qualify as Metropolitan Areas. However, it has not been possible to establish the metropolitan boundary of each center according to the delimitation criteria described above. Where data required by the criteria could not be secured, it was necessary to accept the political limits of the city as the boundary of the Metropolitan Area. This applies to 217 of the 906 Metropolitan Areas listed in the Appendix, with 147 of these 217 cities located in the U.S.S.R.[13] Each of the 217 cities qualifies as a M.A. on the basis of size alone, and is so treated, but it should be noted that the outer limits of "metropolitan" territory have not been established in these cases. Although the influence of political limits on the magnitude of the growth rate cannot be determined for individual cases, there is reason to believe that such influence is minimal, at least for a large number of the cities. Practically all of the cities outside the U.S.S.R. are located in the less industrialized countries and territories, where, as International Urban Research has found, urbanized territory does not extend beyond the political limits of cities to the extent that it does in highly industrialized societies.

Another limitation of the data is associated with changes in urban boundaries. Ideally, the study of a city's growth should be based on two delimitations of urbanized territory—one at the start of the period and one at the end. If the boundary is established at the start of the period and held constant throughout, the rate of growth will not reflect expansion of the urban area. On the other hand, if only the boundary at the end of the period is considered, it may encompass territory which was rural at the start of the period; and, since rural populations tend to increase at a slower rate than urban populations, the incorporation of rural territory results in a lower rate of growth. Thus, in both cases a fixed boundary tends to

[12] China (mainland) accounts for 103 of the 158 M.A.'s *not* included in the study.

[13] Cases where political limits of the city have been used are identified in the Appendix.

produce an understatement of population increase, but the understatement is likely to be far less when the boundary is established at the end rather than the beginning of the period, since the rural population is generally too small to influence appreciably the rate of growth. Fortunately, in the vast majority of cases, the M.A. boundaries were established at the end of the growth period (the latest census year in most instances).[14] Consequently, although the rates probably understate the true amount of growth, the understatement is minimized by the use of boundaries established at the end of the growth period.

Another important consideration is the source of statistics on metropolitan populations. Growth rates should be based on census enumerations; however, this requirement would have sharply reduced world coverage. For this reason, it was deemed necessary to use population estimates for 128 of the 906 Metropolitan Areas.[15] There is no way to evaluate the reliability of these rates, except to note that they are official and believed to be based on a registration system. It is nonetheless necessary to exercise considerable caution in assessing those growth rates which are based on population estimates, each of which is identified in the Appendix.

The final limitation to be considered relates to the years of the growth periods. As shown in the Appendix, the initial and terminal years vary from one country to another. While inequalities in the length of the periods are taken into account by the use of average annual rates, the figures reported in the Appendix describe growth in each M.A. only for certain designated years. Accordingly, comparisons of the same M.A.'s during other periods might well yield results substantially different from those reported here, and in any given case the growth rates reported in the Appendix do not necessarily reflect the current situation. This is all the more true for M.A.'s that were scenes of military action in World War II. Where the growth rates of these M.A.'s are wholly or partially based on war years, they are probably far below current rates.

Variations in periods is of particular importance with regard to estimating current growth of all the world's Metropolitan Areas. If the populations of M.A.'s have been increasing on the average at an accelerated rate, the data in the Appendix will underestimate current levels of increase, since they cover a broad range of time. However, the figures shown in Table 1 suggest that there is no close relationship between the M.A. growth rates and either the initial or the terminal year of the growth periods. It is possible, of course, that countries with low M.A. growth rates just happened to have late census years. It is also possible that even more recent data would show a clear-cut pattern of acceleration. However, as far as the present statistics are concerned, rates of increase are not closely correlated with the recency of either the initial or the terminal year of the growth period.

SOME M.A. GROWTH PATTERNS AMONG MAJOR WORLD REGIONS

Table 2 provides an over-all picture of the distribution of M.A. growth rates in each world region and the world as a whole.[16] The cumulative distribution statistics in Table 2 show the percentage of M.A.'s in each region and the world that grew at less than a designated rate. Thus, for example, none of the world's Metropolitan Areas grew at a rate exceeding 13 percent per annum, while some of them decreased more than 2 percent a year.

[14] The M.A.'s of Australia are exceptions; their boundaries were established at the beginning of the growth period (1947–1954). Growth rates for U.S.S.R. cities are based on the 1939 and 1959 population within the 1959 boundaries.

[15] Estimates were used for both the initial and terminal years of the growth period in 12 of the 128 cases.

[16] The countries and territories included in each region are listed in the Appendix. They were grouped in terms of general geographical, economic, and political considerations, as well as spatial contiguity (with separations by water ignored). The names and boundaries of the regions are in line with common usage, but certain questionable groupings will be apparent. For example, Greece is the only noncommunist country included in Eastern Europe; it was included only after examination indicated that its inclusion would not appreciably influence differences in regional growth rates. Heterogeneity is conspicuous in several of the regions. It was necessary, for example, to group the Union of South Africa with the far less industrialized territories of central Africa to obtain a sufficient number of M.A.'s in the region designated as Southern Africa.

TABLE 1.—NUMBER AND GROWTH RATES OF METROPOLITAN AREAS BY INITIAL AND TERMINAL YEAR OF GROWTH PERIODS

Years	Number of M.A.'s by initial year of growth period	Mean of M.A. growth rates by initial year of growth period	Number of M.A.'s by terminal year of growth period	Mean of M.A. growth rates by terminal year of growth period
–1929	13	2.3	0	—
1930–34	109	1.5	0	—
1935–39	234	2.2	0	—
1940–44	311	2.8	1	1.8
1945–49	78	3.1	29	2.8
1950–54	161	2.1	490	2.3
1955–59	0	—	386	2.4

General Patterns

Perhaps the most outstanding feature of Table 2 is that the M.A. growth rates in the less industrialized regions (Southern Asia, the Middle East, and Southern Africa) appear to be much higher on the average than those in the highly industrialized regions (Oceania, North America, and Western Europe).[17]

Extreme Differences

Southern Africa and Western Europe provide the most clear-cut regional difference in M.A. growth rates. 85.2 percent of Western Europe's Metropolitan Areas increased at less than a rate of 2.0, but none of the Metropolitan Areas in Southern Africa failed to exceed that rate. Considering the range of M.A. growth rates within regions, the most pronounced difference is found in a comparison of Oceania and Eastern Asia. The range in the former is from 0.0 to 4.0, while in the latter it is from 0.0 to 13.0. Also to be noted is that the distributional patterns for Western Europe and Oceania bear little correspondence to the pattern for the world as a whole.

Marked Similarities

The distribution patterns for North America, the U.S.S.R., and Eastern Asia are very much alike. Each one of them also bears a very close correspondence to the world as a whole. For example, the rate of growth for 46.5 percent of the world's M.A.'s is less than 2.0, while the corresponding percentages for North America, U.S.S.R., and Eastern Asia are 46.9, 44.8, and 46.8, respectively.

Deviant Cases

Despite the differences and similarities noted above, the over-all pattern is by no means simple and clear-cut. Consider, for example, the lack of correspondence between the M.A. growth rates in North America and those in Western Europe—two of the world's most highly industrialized regions. Note also

[17] Judgments regarding regional levels of industrialization in this report are based on general observations rather than standardized measures.

TABLE 2.—PERCENT OF METROPOLITAN AREAS IN EACH WORLD REGION GROWING AT LESS THAN A DESIGNATED RATE, *CIRCA* 1941–1953

World regions[1]	Rate of growth[2]															
	–3.0	–2.0	–1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
Eastern Asia				0.0	15.2	46.8	72.1	83.5	91.1	94.7	94.7	96.0	97.3	98.6	98.6	98.6	100.0
Southern Africa						0.0	26.7	40.0	53.3	66.6	73.3	80.0	86.7	93.4	100.0		
North Africa				0.0	4.8	23.8	33.3	71.4	80.9	90.4	90.4	95.2	95.2	95.2	100.0		
Middle America					0.0	8.0	16.0	48.0	80.0	96.0	96.0	96.0	100.0				
Middle East					0.0	15.4	23.1	46.2	61.6	77.0	92.4	100.0					
South America				0.0	2.2	8.9	53.3	64.4	80.0	88.9	97.8	100.0					
North America		0.0	1.3	3.8	11.9	46.9	69.4	81.9	93.2	97.0	98.9	100.0					
U.S.S.R.	0.0	0.7	0.7	2.7	14.9	44.8	67.9	86.9	97.8	98.5	98.5	100.0					
Southern Asia		0.0	0.9	1.8	3.6	9.0	37.8	72.0	87.3	94.5	100.0						
Eastern Europe			0.0	19.6	37.5	48.2	69.6	83.9	94.6	100.0							
Oceania				0.0	9.1	27.3	54.6	100.0									
Western Europe	0.0	0.4	0.4	9.4	46.2	85.2	99.1	100.0									
World	0.0	0.2	0.5	4.8	20.3	46.5	68.2	83.2	92.5	96.4	98.2	99.2	99.5	99.7	99.9	99.9	100.0

Source of data: International Urban Research, *The World's Metropolitan Areas*, and census reports of individual countries and territories.

[1] See Appendix for listing of countries and territories in each region.

[2] Average annual percent increase.

that the amount of variation in M.A. growth rates is much greater in some regions than in others, but there is no obvious correlation with level of industrialization.

VARIATION IN THE GROWTH RATES OF METROPOLITAN AREAS

Differences in the growth rates of regions or countries are of particular importance in a consideration of why some of the world's cities experience increases in population while others do not. The importance of such differences is best understood in connection with the observation that communities are becoming more and more subject to the influence of regional and national conditions.[18] If this observation is valid, then a substantial amount of variation in the growth rates of the world's cities may be due to differences among regions and nations. One possibility in this connection is that the growth of an urban center may be partially contingent on the rate of population increase for the region or nation in which it is located.[19]

Space limitations preclude a thorough analysis of this proposition, but a few general observations can be made.[20] If it is true that the growth rates of the Metropolitan Areas reflect regional and national conditions or, more specifically, that they are to some extent dependent upon total population growth, then we should find that the M.A. rates vary far more between regions than they do within regions.

Differences in the regional means (i.e., arithmetic averages) of the M.A. growth rates shown in the second column of figures in Table 3 indicate the amount of regional variation in metropolitan growth. Considerable regional variation is evident. For example, while the mean of the growth rates for the world as a whole is 2.4, it is 5.3 for Southern Africa and only 1.0 for Western Europe.

TABLE 3.—GROWTH RATES OF METROPOLITAN AREAS: THEIR MEAN, STANDARD DEVIATION, EXTREMES, AND RANGE WITHIN WORLD REGIONS, *CIRCA* 1941–1953

World regions[1]	Number of metropolitan areas	Growth rates[2]				
		Mean	Standard deviation	Extremes[3]		Range[4]
Southern Africa	15	5.3	2.60	2.3	10.8	8.5
Middle East	13	4.5	1.72	1.7	7.6	5.9
Middle America	25	4.0	1.42	1.3	8.2	6.9
North Africa	21	3.7	2.18	0.8	10.4	9.6
South America	45	3.5	1.60	0.8	7.3	6.5
Southern Asia	111	3.4	1.40	−1.8	6.9	8.7
Eastern Asia	79	2.6	2.05	0.1	12.6	12.5
North America	160	2.4	1.54	−1.6	7.1	8.7
Oceania	11	2.4	0.83	0.8	3.5	2.7
U.S.S.R.	147	2.3	1.47	−3.0	7.7	10.7
Eastern Europe	56	1.9	1.78	−0.9	5.6	6.5
Western Europe	223	1.0	0.84	−2.7	3.9	6.6
World	906	2.4	1.78	−3.0	12.6	15.6

Sources of data: International Urban Research, *The World's Metropolitan Areas*, and census reports of the individual countries and territories.

[1] See the Appendix for a listing of the countries and territories included in each region.

[2] Average annual percent increase in population.

[3] Lowest and highest growth rates among the Metropolitan Areas.

[4] Difference between the lowest growth rate and the highest growth rate.

Data in the last four columns of Table 3 make it abundantly clear that M.A.'s in the same region may have widely different growth rates. Consider, for example, the fact that the *standard deviation* of the growth rates in six of the 12 regions is more than one-half the value of the regional mean.[21] When we inspect the last three columns of Table 3 the extent of intraregional variation is even more apparent. In three regions as much as 10 points separate the lowest from the highest M.A. growth rate. Moreover, as can be seen in the last column, in only one region (Oceania) is the gap between the highest and the lowest

[18] See Gideon Sjoberg, "Urban Community Theory and Research: A Partial Evaluation," *American Journal of Economics and Sociology*, Vol. 14 (1955), pp. 199–206.

[19] This is only one of several propositions that stem from the general idea that individual urban centers are becoming more and more subject to national or regional conditions. If these conditions are such that the total population of the country increases, then it is reasonable to assume that urban centers subject to these conditions will also grow. On the other hand, particular *types* of centers may grow even though the total population does not. Moreover, the national characteristics associated with uniformly high rates of growth in the individual centers have yet to be identified; however, a rapid increase in the total population is probably one such characteristic.

[20] The Appendix provides data for an analysis of the relationship between the rates of growth of nations and the M.A.'s contained within them.

[21] Because of a small number of cases and skewed distributions in some of the regions, the standard deviation is considered here only as a measure of absolute dispersion about the mean; and it should not be interpreted as it is when applied to a normal probability distribution.

extremes less than the difference between the means of the rates in Western Europe and Southern Africa.

These observations indicate that predictions of the growth rates of individual M.A.'s from the regional mean are subject to a great deal of error; but the crucial question has yet to be considered: to what extent is the variation in M.A. growth rates between regions greater than the variation within regions? The appropriate statistical technique for providing an answer is analysis of variance.[22]

Application of this technique has revealed that the ratio (F) of the variance between regions to that within regions is 35 to 1. This is a very high ratio, and were it based on a random sample the value of $P(F_{11,894})$ ascribed to it would be less than .001.

This result suggests that M.A. growth rates within regions are far more homogeneous than their standard deviations and range might suggest. Perhaps even more convincing evidence is provided through a consideration of the regional means and the growth rates of extreme cases, as shown in Table 3. If the growth rates of individual M.A.'s were unrelated to regional conditions, and thereby unrelated to each other, we would find that the correspondence between the regional mean rate and the rate of any given M.A. is largely fortuitous; and this would be particularly true for M.A.'s that represent extreme cases. A comparison of the regional means and corresponding extreme rates in Table 3 shows that this is not the case. There is a direct relationship between the regional mean and the lowest M.A. growth rate in the region, and the same is true for the highest rate. *Rho* is +.85 in the first case and +.62 in the second. Thus, the findings suggest that the average growth of all of the M.A.'s in a region sets certain limits on the growth of any particular one.[23]

These results do not demonstrate, of course, that a very close relationship holds between regional rates of growth and that of individual M.A.'s, but the homogeneity of the rates within regions and the predictability of highest and lowest rates within regions provide a basis for pursuing the hypothesis in subsequent research.

Further comparative analysis, in addition to determining the extent of the relationship between regional and individual city growth rates, should seek to identify the conditions that produce regional and national homogeneity in the growth rates of Metropolitan Areas. Of equal importance, research should be initiated to determine what types of cities remain least influenced by regional and national conditions.

APPENDIX

The average annual percent growth rate of each of 906 of the world's Metropolitan Areas, grouped by countries and territories within global regions, is reported in this appendix. Each growth rate is based on the formula: $r = 200(P_2 - P_1)/y(P_2 + P_1)$, with r the average annual percent increase, P_1 the population at the beginning of the period, P_2 the population at the end of the period, and y the number of years in the period. The two numbers after the name of each country or territory represent the initial and terminal years of the growth period for the country or territory and the Metropolitan Areas in it (e.g., FRANCE, 36–54). Unless indicated otherwise, the growth rates are based on census data, and in cases where it was necessary to employ estimates the letter "e" follows the year to which the estimate pertains (e.g., PERU, 40–55e).

For purposes of comparing population growth in the country or territory as a whole with that in individual Metropolitan Areas, two figures follow the terminal year of the growth period. The first figure is the average annual percent growth of the total national population, and the second is the average annual percent growth of the total metropolitan population (e.g., FRANCE, 36–54; 0.2; 0.4).

Two figures follow the name of each Metropolitan Area, which is given in italic letters, with the first figure representing the growth rate and the second the population size of the unit at the beginning of the growth period (e.g., *London*, 0.4; 9,549,371). The population size of each Metropolitan Area at the end of the growth period is reported in International Urban Research, *The World's Metropolitan Areas* (Berkeley and Los Angeles: University of California Press, 1959).

Where the absence of information made it necessary to use administrative limits rather than a metropolitan boundary, the name of the city is given in roman letters (e.g., Mandalay). Only cities with 100,000 or more inhabitants at the end of the growth period are considered.

Some countries and territories with at least one Metropolitan Area or city of 100,000 or more inhab-

[22] The use of analysis of variance in this case can be questioned because of indications that the underlying assumptions are not entirely satisfied by the data. The technique is deemed applicable here, however, as a preliminary step toward the development of more appropriate techniques.

[23] The relationship just considered cannot be attributed to the fact that the extreme growth rates enter into the computation of the regional mean. When the highest, or the lowest, rate is excluded from consideration, the ranks of the regional means remain virtually unchanged.

itants are not included in this list. These are cases where it was not possible to secure data necessary to compute growth rates. Countries and territories excluded are: Ethiopia, Eritrea, Nigeria, Rhodesia, Nyasaland, Sudan, Haiti, British West Indies, Bolivia, Ecuador, Paraguay, Uruguay, Afghanistan, Cambodia, mainland China, Iran, Jordan, North Korea, Kuwait, Lebanon, Nepal, Saudi Arabia, Syria, North Vietnam, and South Vietnam.

NORTH AFRICA

ALGERIA, 48–54; 1.6; 2.9: *Algiers*, 3.1; 488,893. *Bône*, 1.7; 102,823. *Constantine*, 3.7; 118,774. *Oran*, 2.7; 264,421.

EGYPT, 37–47; 1.7; 4.2: *Alexandria*, 2.9; 685,736. *Cairo*, 4.6; 1,349,875. *El Mahalla el Kubra*, 5.9; 63,292. *Mansura*, 3.9; 69,036. *Port Said*, 3.5; 124,749. *Suez*, 7.3; 49,686. *Tanta*, 3.8; 95,260.

FRENCH WEST AFRICA, 46e–55; 1.8; 5.5: *Abidjan*, 10.4; 46,000. *Dakar*, 3.3; 171,200.

LIBYA, 36–54; 1.4; 1.4: *Tripoli*, 1.4; 101,851.

MOROCCO, 36e–51e; 1.6; 3.7: Casablanca, 5.8; 268,069. Fez, 1.4; 144,424. Marrakesh, 0.8; 190,314. Meknes, 4.1; 74,702. Rabat–Salé, 3.7; 115,202. Tangier (37e–51e), 3.2; 95,000.

TUNISIA, 46–56e; 1.6; 1.2: *Tunis*, 1.2; 414,800.

SOUTHERN AFRICA

ANGOLA, 40–50; 1.0; 8.4: *Luanda*, 8.4; 66,932.

BELGIAN CONGO, 40e–53e; 1.2; 10.3: *Elisabethville*, 9.4; 31,094. *Léopoldville*, 10.8; 49,972.

GHANA, 31–48; 1.5; 2.9: *Accra*, 2.9; 135,009.

KENYA, 48–56e; 1.6; 6.9: *Nairobi*, 6.9; 118,976.

MADAGASCAR, 36e–51e; 0.9; 2.8: Tananarive, 2.8; 119,000.

TANGANYIKA, 52–57; 2.0; 5.2: *Dar-es-Salaam*, 5.2; 99,140.

UNION OF SOUTH AFRICA, 46–51; 2.1; 3.6: *Bloemfontein*, 3.2; 111,009. *Cape Town*, 4.1; 516,833. *Durban*, 4.9; 407,669. *East London*, 2.3; 118,377. *Johannesburg*, 2.7; 1,402,015. *Port Elizabeth*, 5.1; 166,739. *Pretoria*, 3.2; 331,886. *Vereeniging–Vanderbijlpark*, 7.3; 105,897.

NORTH AMERICA

CANADA, 51–56; 2.8; 3.6: *Calgary*, 4.1; 177,441. *Edmonton*, 7.0; 235,475. *Halifax*, 4.0; 162,217. *Hamilton*, 4.3; 310,086. *London*, 3.3; 162,139. *Montreal*, 3.3; 1,454,645. *Ottawa*, 3.2; 334,829. *Quebec*, 2.5; 296,515. *Toronto*, 4.2; 1,319,383. *Vancouver*, 3.3; 649,238. *Victoria*, 3.5; 215,003. *Windsor*, 2.6; 217,150. *Winnipeg*, 2.6; 441,458.

UNITED STATES, 40–50; 1.3; 2.0: *Akron, Ohio*, 1.9; 339,405. *Albany – Schenectady – Troy, N.Y.*, 1.0; 465,643. *Albuquerque, N.Mex.*, 7.1; 69,391. *Allentown–Bethlehem–Easton, Pa.*, 1.0; 396,673. *Altoona, Pa.*, –0.1; 140,358. *Asheville, N.C.*, 1.3; 108,755. *Atlanta, Ga.*, 2.6; 518,100. *Atlantic City, N.J.*, 0.6; 124,066. *Augusta, Ga.*, 2.1; 131,779. *Austin, Texas*, 3.7; 111,053. *Baltimore, Md.*, 2.1; 1,083,300. *Baton Rouge, La.*, 5.7; 88,415. *Beaumont–Port Arthur, Texas*, 2.9; 145,329. *Binghamton, N.Y.*, 1.1; 165,749. *Birmingham, Ala.*, 1.9; 459,930. *Boston – Lawrence – Lowell, Mass.*, 0.8; 2,656,131. *Bridgeport–Stamford–Norwalk, Conn.*, 1.9; 418,384. *Brockton, Mass.*, 1.2; 168,824. *Buffalo, N.Y.*, 1.3; 958,487. *Canton, Ohio*, 1.9; 234,887. *Cedar Rapids, Iowa*, 1.6; 89,142. *Charleston, S.C.*, 3.1; 121,105. *Charleston, W.Va.*, 1.5; 276,247. *Charlotte, N.C.*, 2.6; 151,826. *Chattanooga, Tenn.*, 1.5; 211,502. *Chicago, Ill.*, 1.3; 4,825,527. *Cincinnati, Ohio*, 1.4; 787,044. *Cleveland, Ohio*, 1.5; 1,267,270. *Columbia, S.C.*, 3.0; 104,843. *Columbus, Ga.*, 3.0; 126,407. *Columbus, Ohio*, 2.6; 388,712. *Corpus Christi, Texas*, 5.6; 92,661. *Dallas, Texas*, 4.3; 398,564. *Davenport, Iowa–Rock Island –Moline, Ill.*, 1.7; 198,071. *Dayton, Ohio*, 3.2; 331,343. *Denver, Colo.*, 3.2; 407,768. *Des Moines, Iowa*, 1.4; 195,835. *Detroit, Mich.*, 2.4; 2,377,329. *Duluth, Minn.–Superior, Wis.*, –0.0; 254,036. *Durham, N.C.*, 2.4; 80,244. *El Paso, Texas*, 3.9; 131,067. *Erie, Pa.*, 1.9; 180,889. *Evansville, Ind.*, 2.0; 130,783. *Fall River – New Bedford, Mass.*, 0.5; 364,637. *Flint, Mich.*, 1.7; 227,944. *Fort Wayne, Ind.*, 1.7; 155,084. *Fort Worth, Texas*, 4.6; 225,521. *Fresno, Calif.*, 4.3; 178,565. *Galveston, Texas*, 3.3; 81,173. *Grand Rapids, Mich.*, 1.6; 246,338. *Greensboro–High Point, N.C.*, 2.2; 153,916. *Greenville, S.C.*, 2.1; 136,580. *Hamilton–Middletown, Ohio*, 2.0; 120,249. *Harrisburg, Pa.*, 1.5; 252,216. *Hartford – New Britain – Bristol, Conn.*, 1.8; 450,189. *Houston, Texas*, 4.2; 528,961. *Huntington, W.Va.–Ashland, Ky.*, 0.9; 225,668. *Indianapolis, Ind.*, 1.8; 460,926. *Jackson, Mich.*, 1.5; 93,108. *Jackson, Miss.*, 2.8; 107,273. *Jacksonville, Fla.*, 3.7; 210,143. *Johnstown, Pa.*, –0.2; 298,416. *Kalamazoo, Mich.*, 2.3; 100,085. *Kansas City, Mo.*, 1.7; 686,643. *Knoxville, Tenn.*, 3.1; 246,088. *Lancaster, Pa.*, 1.0; 212,504. *Lansing, Mich.*, 2.8; 130,616. *Lexington, Ky.*, 2.4; 78,899. *Lincoln, Nebr.*, 1.7; 100,585. *Little Rock–North Little Rock, Ark.*, 2.3; 156,085. *Lorain–Elyria, Ohio*, 2.7; 112,390. *Los Angeles, Calif.*, 4.0; 2,916,403. *Louisville, Ky.*, 2.4; 451,473. *Lubbock, Texas*, 6.4; 51,782. *Macon, Ga.*, 3.5; 95,086. *Madison, Wis.*, 2.6; 130,660. *Manchester, N.H.*, 0.8; 144,888. *Memphis, Tenn.*, 3.0; 358,250. *Miami, Fla.*, 6.0; 267,739. *Milwaukee, Wis.*, 1.3; 766,885. *Minneapolis–St. Paul, Minn.*, 1.7; 940,937. *Mobile, Ala.*, 4.8; 141,974. *Montgomery, Ala.*, 1.9; 114,420. *Nashville, Tenn.*, 2.2; 257,267. *New Haven–Waterbury, Conn.*, 1.2; 484,316. *New Orleans, La.*, 2.2; 552,244. *New York–Northeastern New Jersey*, 1.0; 11,660,839. *Norfolk–Portsmouth, Va.*, 5.3; 258,927. *Oklahoma City, Okla.*, 2.9; 244,159. *Omaha, Nebr.*, 1.2; 325,153. *Orlando, Fla.*, 4.9; 70,074. *Peoria, Ill.*, 1.7; 211,736. *Philadelphia, Pa.*, 1.4; 3,199,637. *Phoenix, Ariz.*, 5.6; 186,193. *Pittsburgh, Pa.*, 0.6; 2,082,556. *Pittsfield, Mass.*, 0.8; 122,273. *Portland, Maine*, 1.5; 146,000. *Portland, Oregon*, 3.4; 501,275. *Providence, R.I.*, 0.7; 634,157. *Racine, Wis.*, 1.5; 94,047. *Raleigh, N.C.*, 2.2; 109,544. *Reading, Pa.*, 0.6; 241,884. *Richmond, Va.*, 2.2; 262,991. *Roanoke, Va.*, 1.7; 112,184. *Rochester, N.Y.*, 1.1; 438,230. *Rockford, Ill.*, 2.3; 121,178. *Sacramento, Calif.*, 4.8; 170,333. *Saginaw, Mich.*, 1.6; 130,468. *St. Louis, Mo.*, 1.6; 1,432,088. *Salt Lake City, Utah*, 2.6; 211,623. *San Antonio, Texas*, 3.9; 338,176. *San Bernardino, Calif.*, 5.4; 161,108. *San Diego, Calif.*, 6.3; 289,348. *San Francisco–Oakland, Calif.*, 4.2; 1,461,804. *San Jose, Calif.*, 5.0; 174,949. *Savannah, Ga.*, 2.5;

117,970. *Scranton, Pa.*, –1.6; 301,243. *Seattle, Wash.*, 3.7; 504,980. *Shreveport, La.*, 1.6; 150,203. *Sioux City, Iowa*, 0.0; 103,627. *South Bend, Ind.*, 2.4; 161,823. *Spokane, Wash.*, 2.9; 164,652. *Springfield, Ill.*, 1.1; 117,912. *Springfield, Mo.*, 1.5; 90,541. *Springfield, Ohio*, 1.5; 95,647. *Springfield–Holyoke, Mass.*, 1.2; 404,568. *Stockton, Calif.*, 4.0; 134,207. *Syracuse, N.Y.*, 1.5; 295,108. *Tacoma, Wash.*, 4.1; 182,081. *Tampa–St. Petersburg, Fla.*, 4.0; 272,000. *Terre Haute, Ind.*, 0.5; 99,709. *Toledo, Ohio*, 1.4; 344,333. *Topeka, Kansas*, 1.4; 91,247. *Trenton, N.J.*, 1.5; 197,318. *Tulsa, Okla.*, 2.6; 193,363. *Utica–Rome, N.Y.*, 0.8; 263,-163. *Waco, Texas*, 2.4; 101,898. *Washington, D.C.*, 4.1; 967,985. *Waterloo, Iowa*, 2.3; 79,946. *Wheeling, W.Va.–Steubenville, Ohio*, –0.3; 364,132. *Wichita, Kansas*, 4.3; 143,311. *Wilkes-Barre–Hazleton, Pa.*, –1.2; 441,518. *Wilmington, Del.*, 1.9; 221,836. *Winston–Salem, N.C.*, 1.4; 126,475. *Worcester, Mass.*, 0.8; 504,470. *York, Pa.*, 1.3; 178,022. *Youngstown, Ohio*, 1.1; 473,605.

MIDDLE AMERICA

COSTA RICA, 27–50; 2.3; 3.0: *San José*, 3.0; 77,092.

CUBA, 43–53; 1.9; 2.7: *Camagüey*, 3.1; 80,509. *Havana*, 2.6; 956,321. *Santiago de Cuba*, 3.2; 120,-577.

DOMINICAN REPUBLIC, 35–50; 2.4; 4.6: *Ciudad Trujillo*, 4.6; 116,992.

EL SALVADOR, 30–50; 1.3; 3.0: *San Salvador*, 3.0; 119,060.

GUATEMALA, 40–50; 2.0; 4.5: *Guatemala City*, 4.5; 185,896.

HONDURAS, 40–50; 2.1; 4.2: *Tegucigalpa*, 4.2; 65,000.

MEXICO, 40–50; 2.7; 5.0: *Aguascalientes*, 1.3; 104,-268. *Chihuahua*, 3.5; 78,850. *Ciudad Juárez*, 8.2; 55,024. *Guadalajara*, 4.7; 257,229. *Léon*, 4.1; 103,305. *Mérida*, 3.2; 115,244. *Mexico City*, 5.5; 1,685,626. *Monterrey*, 5.8; 201,394. *Puebla*, 5.1; 148,701. *San Luis Potosí*, 4.5; 97,762. *Tampico*, 2.0; 112,428. *Torreón–Gómez Palacio*, 4.9; 140,-236. *Veracruz*, 3.6; 77,101.

NICARAGUA, 40–50; 2.3; 5.1: *Managua*, 5.1; 83,355.

PANAMA, 40–50; 2.6; 3.6: *Panama City*, 3.6; 133,346.

PUERTO RICO, 40–50; 1.7; 3.7: *Ponce*, 1.9; 105,116. *San Juan*, 4.2; 302,765.

SOUTH AMERICA

ARGENTINA, 14–47; 2.0; 2.4: *Bahía Blanca*, 1.6; 70,-269. *Buenos Aires*, 2.4; 2,034,814. *Córdoba*, 2.9; 134,935. *La Plata*, 2.3; 137,413. *Mar del Plata*, 3.5; 32,940. *Mendoza*, 2.3; 99,282. *Paraná*, 2.1; 71,848. *Rosario*, 2.0; 269,459. *San Juan*, 2.5; 50,-527. *Santa Fe*, 2.7; 79,287. *Tucumán*, 2.1; 100,080.

BRAZIL, 40–50; 2.3; 4.2: *Belém*, 2.1; 206,331. *Belo Horizonte*, 5.0; 211,377. *Campinas*, 2.7; 116,669. *Curitiba*, 2.5; 140,656. *Fortaleza*, 4.0; 180,185. *João Pessoa*, 2.3; 94,333. *Juiz de Fora*, 2.0; 104,-172. *Maceió*, 2.9; 90,253. *Natal*, 6.1; 54,836. *Pôrto Alegre*, 4.0; 289,862. *Recife*, 4.2; 450,526. *Rio de Janeiro*, 4.0; 2,033,107. *Salvador*, 3.6; 290,-443. *Santos*, 2.6; 190,401. *São Luís*, 3.3; 85,583. *São Paulo*, 5.3; 1,424,574.

BRITISH GUIANA, 31–46; 1.1; 2.0: *Georgetown*, 2.0; 69,663.

CHILE, 40–52; 1.6; 2.6: *Concepción–Talcahuano*, 4.0; 135,145. *Santiago*, 2.9; 1,007,345. *Valparaíso*, 0.8; 285,627.

COLOMBIA, 38–51; 2.2; 5.4: *Barranquilla*, 4.4; 171,-554. *Bogotá*, 5.2; 355,502. *Bucaramanga*, 5.7; 51,283. *Cali*, 7.3; 101,883. *Cartagena*, 3.2; 84,937. *Manizales*, 2.9; 86,027. *Medellín*, 6.9; 168,266. *Pereira*, 4.8; 60,492.

PERU, 40–55e; 1.9; 3.5: *Arequipa*, 1.5; 128,809. *Lima*, 3.8; 645,172.

VENEZUELA, 41–50; 3.0; 5.8: *Barquisimeto*, 2.4; 93,904. *Caracas*, 6.9; 414,802. *Maracaibo*, 6.4; 144,465. *Valencia*, 1.2; 91,131.

SOUTHERN ASIA

BURMA, 31–53; 1.2; 2.3: Mandalay, 1.0; 147,932. Moulmein, 2.0; 65,506. Rangoon, 2.7; 400,415.

CEYLON, 46–53; 2.8; 2.9: *Colombo*, 2.9; 634,762.

INDIA, 41–51; 1.3; –3.8: *Agra*, 2.8; 284,149. *Ahmedabad*, 3.5; 649,874. *Ajmer*, 2.9; 147,258. *Aligarh*, 2.3; 112,655. *Allahabad*, 2.4; 260,630. *Alleppey*, 6.9; 56,332. *Amravati*, 3.1; 90,346. *Amritsar*, –1.8; 391,010. *Banaras (Varanasi)*, 3.0; 263,100. *Bangalore*, 6.2; 495,657. *Bareilly*, 0.8; 192,688. *Baroda*, 3.2; 153,301. *Bhagalpur*, 2.0; 93,254. *Bhavnagar*, 2.9; 102,851. *Bhopal*, 3.1; 75,-228. *Bikaner*, 0.2; 127,226. *Bombay*, 5.5; 1,936,-114. *Calcutta*, 2.4; 4,071,335. *Coimbatore*, 4.1; 130,348. *Cuttack*, 3.2; 74,291. *Dehra Dun*, 5.9; 78,228. *Delhi*, 6.4; 917,939. *Gaya*, 2.4; 105,223. *Gorakhpur*, 2.9; 98,977. *Guntur*, 4.0; 83,599. *Gwalior*, 2.8; 182,492. *Hubli*, 3.0; 95,512. *Hyderabad*, 3.8; 739,159. *Indore*, 4.2; 203,695. *Jabalpur*, 3.6; 178,339. *Jaipur*, 4.9; 175,810. *Jamnagar*, 3.7; 71,588. *Jamshedpur*, 2.8; 165,395. *Jhansi*, 2.1; 103,254. *Jodhpur*, 3.5; 126,842. *Jullundur*, 4.1; 110,969. *Kanpur*, 3.7; 487,324. *Kharagpur*, 3.9; 87,185. *Kolar Gold Fields*, 1.7; 133,859. *Kolhapur*, 3.8; 93,032. *Kozhikode*, 2.3; 126,352. *Lucknow*, 2.5; 387,177. *Ludhiana*, 3.2; 111,639. *Madras*, 5.3; 1,004,515. *Madurai*, 4.1; 239,144. *Mangalore*, 3.6; 81,069; *Mathura*, 2.7; 80,532. *Meerut*, 3.2; 169,-290. *Moradabad*, 1.3; 142,414. *Mysore*, 4.7; 150,-540. *Nagpur*, 3.9; 301,957. *Patna*, 3.6; 196,415. *Poona*, 5.1; 351,233. *Rajahmundry*, 3.4; 74,564. *Rajkot*, 6.6; 66,353. *Rampur*, 4.0; 89,322. *Ranchi*, 5.2; 62,562. *Saharanpur*, 3.1; 108,263. *Salem*, 4.4; 129,702. *Shahjahanpur*, –0.5; 110,163. *Sholapur*, 2.6; 212,620. *Surat*, 2.6; 171,443. *Tanjore*, 3.8; 68,702. *Tiruchirapalli*, 3.1; 159,566. *Tirunelveli-Palayamcottai*, 2.1; 91,643. *Trivandrum*, 3.7; 128,-369. *Ujjain*, 4.6; 81,272. *Vellore*, 3.9; 71,502. *Vijayavada*, 6.1; 86,184. *Visakhapatnam*, 4.2; 70,243. *Warangal*, 3.6; 92,808.

INDONESIA, 30–56e; 1.3; 3.8: Bandjarmasin, 3.5; 65,-698. Bandung, 5.1; 166,815. Bogor, 2.4; 65,431. Djakarta, 4.3; 535,015. Jogjakarta, 2.5; 136,649. Kediri, 3.7; 48,567. Makassar, 4.8; 84,855. Malang, 4.1; 86,646. Medan, 4.6; 76,584. Padang, 3.1; 52,054. Palembang, 3.4; 108,145. Pontianak, 3.5; 45,196. Semarang, 2.0; 217,796. Surabaja, 3.6; 341,675. Surakarta, 2.9; 165,484. Tjirebon, 2.5; 54,079.

KASHMIR (AND JAMMU), 31–41; 1.0; 1.8: *Srinagar*, 1.8; 173,573.

MALAYA, 47–57; 2.4; 4.0: *Ipoh*, 3.5; 155,065. *Kuala Lumpur*, 5.2; 237,142. *Penang* (*George Town*), 2.8; 229,967.

PAKISTAN, 31–51; 1.2; 3.8: *Chittagong*, 2.6; 173,577. *Dacca*, 3.5; 196,111. *Gujranwala*, 3.2; 58,716. *Hyderabad*, 4.1; 101,699. *Karachi*, 5.8; 300,779. *Lahore*, 3.3; 429,747. *Lyallpur*, 6.1; 42,922. *Multan*, 2.3; 119,457. *Peshawar*, 1.1; 121,866. *Rawalpindi*, 3.4; 75,767. *Sialkot*, 2.2; 100,973.

PHILIPPINES, 39–48; 2.0; 4.1: *Cebu*, 1.3; 193,538. *Iloilo*, 2.2; 90,480; *Manila*, 4.7; 1,078,558.

SINGAPORE, 31–47; 3.2; 3.2: *Singapore*, 3.2; 557,745.

THAILAND, 37–47; 1.9; 2.8: *Bangkok*, 2.8; 890,453.

EASTERN ASIA

CHINA: TAIWAN, 40–58e; 2.9; 4.8: Kaohsiung, 5.4; 108,000. Keelung, 3.1; 92,500. Kiayi (excluded from growth study). Taichung, 5.6; 62,500. Tainan, 4.5; 101,000. Taipei, 4.8; 285,000.

HONG KONG, 31–56e; 4.0; 4.0: *Hong Kong*, 4.0; 849,751.

JAPAN, 50–55; 1.4; 3.2: *Akita*, 1.9; 173,029. *Aomori*, 2.7; 160,275. *Asahigawa*, 3.7; 136,697. *Ashikaga*, 0.1; 101,672. *Fukui*, 1.7; 114,876. *Fukuoka*, 3.6; 549,599. *Gifu–Ichinomiya*, 2.6; 460,960. *Hachinoe*, 2.4; 125,458. *Hakodate*, 1.2; 228,994. *Hamamatsu*, 3.3; 234,464. *Himeji*, 1.8; 243,680. *Hirosaki*, 1.1; 131,752. *Hiroshima–Kure*, 2.8; 555,444. *Kagoshima*, 3.6; 229,462. *Kanazawa*, 1.2; 261,456. *Kiryu*, 0.1; 166,744. *Kochi*, 2.2; 161,640. *Kofu*, 2.1; 139,030. *Kumamoto*, 2.7; 290,990. *Kurashiki*, 0.9; 154,169. *Kurume*, 2.7; 121,487. *Kyoto*, 1.6; 1,268,260. *Maebashi–Takasaki*, 0.9; 283,996. *Matsuyama*, 2.5; 187,877. *Miyazaki*, 2.3; 125,611. *Morioka*, 2.2; 127,878. *Muroran*, 2.5; 130,564. *Nagano*, 1.2; 143,494. *Nagaoka*, 1.4; 122,034. *Nagasaki*, 3.2; 285,489. *Nagoya*, 4.0; 1,231,235. *Nara*, 0.6; 111,992. *Niigata*, 1.5; 243,266. *Niihama*, 0.8; 163,199. *Nobeoka*, 2.3; 103,986. *Numazu–Mishima*, 1.6; 205,527. *Odawara*, 1.6; 104,561. *Oita–Beppu*, 2.3; 191,465. *Okayama*, 2.8; 205,025. *Okazaki*, 1.3; 145,977. *Omuda*, 0.8; 259,180. *Onomichi–Mihara*, 0.6; 150,627. *Osaka–Kobe*, 3.6; 5,348,039. *Otaru*, 1.1; 178,330. *Saga*, 1.2; 118,964. *Sapporo*, 4.1; 346,761. *Sasebo*, 2.6; 278,789. *Sendai*, 1.9; 341,685. *Shizuoka–Shimizu*, 2.7; 378,010. *Takamatsu*, 2.9; 130,489. *Takaoka*, 0.8; 126,311. *Tokushima*, 2.0; 155,271. *Tokuyama–Kudamatsu*, 1.0; 166,775. *Tokyo–Yokohama*, 4.5; 9,048,702. *Toyama*, 1.6; 185,359. *Toyohashi*, 1.7; 242,498. *Ube–Onoda*, 1.4; 199,768. *Utsunomiya*, 1.4; 211,266. *Wakayama*, 1.7; 251,217. *Yahata–Shimonoseki–Kokura*, 2.1; 1,493,304. *Yamagata*, 0.6; 155,786. *Yokkaichi*, 1.4; 168,622. *Yoshiwara–Fujinomiya*, 1.3; 161,220.

KOREA, SOUTH, 49–55; 1.1; 5.2: Chonju, 3.5; 100,624. Inchon, 3.1; 265,767. Kwangju, 8.5; 138,883. Mokpo, 0.4; 111,128. Pusan, 12.6; 473,619. Seoul, 1.4; 1,446,019. Taegu, 7.3; 313,705. Taejon, 5.2; 126,704.

MACAU, 27–50; 0.8; 0.8: *Macau*, 0.8; 157,175.

RYUKYU ISLANDS, 50–55; 2.7; 9.0: *Naha*, 9.0; 108,662.

MIDDLE EAST

ADEN COLONY, 46–55; 5.9; 5.9: *Aden*, 5.9; 80,516.

IRAQ, 47–57; 3.0; 5.2: Baghdad, 6.0; 352,137. Basra, 4.7; 101,535. Mosul, 2.9; 133,625.

ISRAEL, 51e–56e; 2.8; 2.9: *Haifa*, 1.7; 204,500. *Jerusalem* (part), 1.7; 153,600. *Tel Aviv–Jaffa*, 3.6; 493,600.

TURKEY, 50–55; 2.8; 5.2: *Adana*, 7.6; 117,642. *Ankara*, 3.9; 335,039. *Bursa*, 4.7; 103,812. *Eskisehir*, 6.2; 89,869. *Istanbul*, 5.7; 1,024,427. *Izmir*, 3.8; 277,180.

WESTERN EUROPE

AUSTRIA, 34–51; 0.1; –0.6: *Graz*, 0.4; 210,845. *Innsbruck*, 1.2; 140,411. *Linz*, 2.5; 162,370. *Salzburg*, 2.3; 69,767. *Vienna*, –0.9; 2,188,714.

BELGIUM, 47–56e; 0.5; 0.6: *Antwerp*, 0.7; 784,313. *Brussels*, 0.6; 1,299,925. *Charleroi*, 0.6; 435,091. *Ghent*, 0.3; 440,864. *Liège*, 0.6; 564,364.

DENMARK, 50–55; 0.8; 1.2: *Aalborg*, 1.2; 105,171. *Aarhus*, 1.5; 156,878. *Copenhagen*, 1.2; 1,219,651. *Odense*, 1.2; 117,138.

FINLAND, 40–50; 0.9; 2.0: *Helsinki*, 1.9; 365,305. *Tampere*, 2.1; 104,367. *Turku*, 2.0; 93,227.

FRANCE, 36–54; 0.2; 0.4: *Angers*, 0.8; 109,378. *Bordeaux*, 0.4; 427,014. *Brest*, –0.1; 147,165. *Clermont–Ferrand*, 0.8; 155,956. *Dijon*, 1.0; 115,955. *Douai*, 0.6; 131,743. *Grenoble*, 1.2; 137,935. *Le Hâvre*, –0.4; 215,905. *Le Mans*, 1.4; 106,463. *Lens–Hénin–Liétard*, 1.1; 299,340. *Lille–Roubaix–Tourcoing*, 0.2; 868,402. *Limoges*, 0.6; 100,365. *Lyon*, 0.3; 773,752. *Marseille*, –0.1; 816,501. *Metz*, 0.6; 156,096. *Montpellier*, 0.4; 93,013. *Mulhouse*, 0.3; 191,648. *Nancy*, 0.4; 259,658. *Nantes*, 0.9; 232,070. *Nice*, –0.1; 302,638. *Orléans*, 0.7; 107,546. *Paris*, 0.4; 6,260,171. *Reims*, 0.2; 124,555. *Rennes*, 1.2; 123,526. *Rouen*, 0.4; 312,986. *Saint-Étienne*, 0.1; 360,614. *Strasbourg*, 0.2; 304,142. *Toulon*, 0.2; 240,386. *Toulouse*, 1.4; 233,622. *Tours*, 0.5; 129,670.

GERMANY, WEST, 50–56e; 1.1; 1.8: *Aachen*, 1.9; 351,768. *Augsburg*, 1.4; 266,826. *Berlin, West*, 0.6; 2,146,952. *Berlin, East and West*, 0.3; 4,199,552. *Bielefeld*, 2.0; 254,897. *Bonn*, 2.0; 460,131. *Braunschweig*, –0.1; 444,670. *Bremen*, 1.2; 616,865. *Bremerhaven*, 2.2; 114,070. *Cologne*, 2.6; 1,059,609. *Darmstadt*, 2.0; 268,356. *Düsseldorf*, 3.9; 707,635. *Essen–Dortmund–Duisburg* (*Inner Ruhr*), 2.5; 4,597,223. *Flensburg*, –2.7; 181,672. *Frankfurt am Main*, 2.3; 1,308,531. *Freiburg*, 2.6; 109,717. *Hamburg*, 1.0; 1,951,988. *Hamm*, 1.4; 132,883. *Hannover*, 1.7; 786,615. *Hildesheim*, –0.2; 199,180. *Karlsruhe*, 1.5; 444,826. *Kassel*, 1.0; 333,460. *Kiel*, 0.1; 254,449. *Koblenz*, 2.6; 133,671. *Krefeld–M. Gladbach–Rheydt*, 1.8; 597,812. *Lübeck*, 1.4; 345,428. *Mannheim–Ludwigshafen–Heidelberg*, 1.6; 1,145,547. *Munich*, 2.1; 1,109,846. *Münster*, 2.7; 209,759. *Nuremberg*, 1.7; 632,293. *Oldenburg*, –0.4; 122,809. *Osnabrück*, 1.1; 227,072. *Pforzheim*, 2.9; 110,085. *Regensburg*, 0.4; 117,291. *Saarbrücken* (51–56e), 0.8; 355,920. *Salzgitter*, –0.1; 100,667. *Stuttgart*, 2.9; 1,129,111. *Wiesbaden–Mainz*, 2.2; 365,333. *Wilhelmshaven*, –0.5; 101,229. *Wuppertal–Solingen–Remscheid*, 1.8; 763,297.

IRELAND (EIRE), 51–56; –0.4; 0.4: *Cork*, 0.3; 144,661. *Dublin*, 0.4; 668,473.

ITALY, 36–51; 0.7; 1.2: *Bari*, 2.0; 204,097. *Bergamo*, 1.3; 190,648. *Bologna*, 1.3; 289,538. *Brescia*, 1.0; 140,301. *Busto Arsizio–Legnano–Gallarate*, 1.2;

218,461. *Cagliari*, 2.0; 120,539. *Carrara–Massa*, 0.7; 106,378. *Catania*, 1.3; 248,052. *Como*, 0.9; 92,919. *Florence*, 0.9; 403,156. *Genoa*, 0.5; 670,-360. *La Spezia*, 0.5; 164,398. *Leghorn*, 0.9; 124,963. *Messina*, 0.9; 192,051. *Milan*, 1.0; 1,702,-440. *Modena*, 1.0; 96,337. *Naples*, 1.2; 1,192,703. *Padua*, 1.2; 147,652. *Palermo*, 1.2; 411,879. *Parma*, 0.8; 109,365. *Reggio di Calabria*, 1.1; 119,804. *Rome*, 2.4; 1,228,416. *Salerno*, 1.6; 122,779. *Taranto*, 2.4; 117,722. *Trieste*, 0.6; 265,915. *Turin*, 1.0; 754,364. *Venice*, 1.2; 289,851. *Verona*, 1.0; 162,725.

MALTA AND GOZO, 31–48; 1.4; 1.2: *Valletta*, 1.2; 157,562.

NETHERLANDS, 47–55e; 1.4; 1.4: *Amsterdam*, 1.0; 936,896. *Arnhem*, 2.0; 153,988. *Dordrecht*, 1.3; 109,030. *Eindhoven*, 1.9; 182,023. *Enschede–Hengelo*, 1.8; 162,192. *Groningen*, 0.9; 147,890. *Haarlem–Velsen*, 1.4; 280,868. *Heerlen–Kerkrade*, 1.9; 193,391. *Leiden*, 1.2; 113,165. *Nijmegen*, 1.5; 123,296. *Rotterdam*, 1.4; 836,199. *The Hague*, 1.4; 687,742. *Tilburg*, 1.5; 121,182. *Utrecht*, 1.4; 333,-484.

NORWAY, 30–50; 0.8; 1.2: *Bergen*, 1.2; 139,516. *Oslo*, 1.2; 418,710.

PORTUGAL, 40–50; 0.9; 1.4: *Lisbon*, 1.5; 893,872. *Oporto*, 1.1; 542,141.

SPAIN, 40–50; 0.8; 1.6: *Alicante*, 0.7; 96,729. *Barcelona*, 1.7; 1,281,604. *Bilbao*, 1.4; 330,601. *Cádiz*, 1.3; 87,767. *Córdoba*, 1.4; 143,296. *Gijón*, 0.9; 101,341. *Granada*, 0.0; 162,203. *La Coruña*, 2.5; 104,220. *Las Palmas de Gran Canaria* (Canary Is.), 2.5; 119,595. *Madrid*, 2.1; 1,341,180. *Málaga*, 1.5; 238,782. *Murcia*, 1.2; 193,731. *Oviedo*, 2.5; 82,548. *Palma de Mallorca*, 1.8; 114,405. *San Sebastián*, 1.0; 135,141. *Santa Cruz de Tenerife* (Canary Is.), 3.5; 72,358. *Santander*, 0.1; 101,793. *Seville*, 2.0; 323,471. *Valencia*, 1.3; 534,323. *Valladolid*, 0.7; 116,024. *Vigo*, 1.1; 123,734. *Zaragoza*, 1.0; 238,601.

SWEDEN, 40–50; 0.5; 2.3: *Göteborg*, 1.9; 351,473. *Malmö*, 2.1; 164,332. *Stockholm*, 2.5; 736,343.

SWITZERLAND, 41–50; 1.1; 1.7: *Basel*, 1.6; 258,449. *Bern*, 1.6; 173,837. *Geneva*, 1.7; 168,010. *Lausanne*, 1.6; 116,933. *Zürich*, 1.8; 454,591.

U.K.: ENGLAND AND WALES, 31–51; 0.5; 0.4: *Aldershot–Farnborough*, 1.0; 113,589. *Barnsley*, 0.2; 181,194. *Birmingham*, 0.8; 2,149,482. *Blackburn–Accrington*, –0.5; 260,692. *Blackpool*, 1.4; 172,-323. *Bournemouth–Poole*, 1.4; 192,518. *Brighton–Worthing*, 1.2; 287,414. *Bristol*, 0.8; 515,365. *Burnley–Nelson*, –0.6; 204,151. *Cambridge*, 0.9; 99,728. *Cardiff–Rhondda*, –0.1; 606,093. *Chatham–Rochester–Gillingham*, 0.8; 154,560. *Chesterfield*, 0.5; 183,282. *Coventry*, 1.4; 385,926. *Darlington–Auckland*, 0.4; 136,834. *Derby*, 0.7; 309,823. *Doncaster*, 0.8; 148,506. *Exeter*, 0.7; 114,549. *Gloucester*, 1.4; 78,122. *Grimsby*, 0.2; 131,824. *Hull*, *Kingston Upon*, 0.1; 330,406. *Ipswich*, 0.9; 87,569. *Lancaster–Morecambe*, 1.3; 80,-820. *Leeds–Bradford*, 0.1; 1,860,139. *Leicester*, 0.8; 364,761. *Liverpool*, 0.3; 1,499,101. *London*, 0.4; 9,549,371. *Luton*, 2.8; 82,544. *Manchester*, –0.02; 2,518,111. *Mansfield–Sutton*, 0.4; 207,370. *Middlesbrough – Stockton – West Hartlepool*, 0.4; 448,364. *Newcastle Upon Tyne*, –0.01; 1,131,446. *Newport–Pontypool*, –0.02; 416,451. *Northampton*, 0.6; 125,940. *Norwich*, 0.5; 195,130. *Nottingham*, 1.0; 493,529. *Oxford*, 1.6; 124,749. *Plymouth*, 0.1; 246,886. *Portsmouth*, 0.5; 333,672. *Port Talbot*, 0.5; 122,134. *Preston*, 1.5; 200,202. *Reading*, 1.2; 160,632. *Saint Helens*, –0.3; 134,920. *Sheffield*, 0.2; 711,246. *Southampton*, 0.7; 307,728. *Stoke on Trent*, 0.4; 455,355. *Sunderland*, –0.1; 237,780. *Swansea–Neath*, –0.1; 310,791. *Swindon*, 0.9; 89,-247. *Warrington*, 1.0; 149,839. *Wigan–Leigh*, 0.1; 292,697. *York*, 0.9; 105,674.

U.K.: NORTHERN IRELAND, 37–51; 0.5; 0.5: *Belfast*, 0.5; 488,653.

U.K.: SCOTLAND, 31–51; 0.3; 0.2: *Aberdeen*, 0.4; 194,780. *Dundee*, 0.03; 194,093. *Edinburgh*, 0.4; 547,868. *Glasgow*, 0.2; 1,803,930. *Greenock*, –0.03; 107,691.

EASTERN EUROPE

BULGARIA, 46–56; 0.8; 3.2: Plovdiv, 2.5; 126,563. *Sofia*, 3.1; 530,168. Varna (Stalin), 4.4; 76,954.

CZECHOSLOVAKIA, 30–50; –0.6; 0.4: Bratislava, 1.0; 156,476. Brno, 0.2; 271,521. Ostrava, –0.1; 186,-545. Plzen, –0.2; 130,589. Prague, 0.5; 848,823.

GERMANY, EAST, 50–55e; –0.4; –0.1: *Berlin, East*, –0.03; 2,052,600. *Berlin, East and West*, 0.3; 4,199,552. *Dessau*, 0.02; 184,300. *Dresden*, –0.04; 742,100. *Erfurt*, –0.4; 253,200. *Gera*, 0.05; 172,-300. *Görlitz*, –0.9; 141,700. *Halle*, –0.1; 539,800. *Jena*, 0.2; 123,300. *Karl-Marx-Stadt* (*Chemnitz*), –0.4; 505,000. *Leipzig*, –0.3; 812,700. *Magdeburg*, –0.4; 488,600. *Rostock*, 1.4; 178,100. *Zwickau*, –0.5; 360,300.

GREECE, 40–51; 0.4; 1.6: *Athens*, 1.8; 1,124,109. *Salonika*, 0.7; 278,145.

HUNGARY, 30–49; 0.3; 0.5: Budapest, 0.5; 1,440,961. Debrecen, 0.3; 117,275. Miskolc, 0.8; 93,912.

POLAND, 50*–56e; 1.8; 3.1: *Bydgoszcz*, 4.3; 162,524. *Czestochowa*, 5.3; 112,198. *Gdansk–Gdynia*, 4.4; 334,800. *Katowice–Zabrze–Bytom* (*Upper Silesia*), 2.3; 1,675,000. *Krakow*, 5.0; 343,638. *Lodz*, 1.6; 768,000. *Lublin*, 3.3; 116,629. *Poznan*, 2.7; 320,-670. *Szczecin*, 4.7; 178,907. *Walbrzych*, 2.5; 148,000. *Warsaw*, 3.4; 1,300,000. *Wroclaw*, 3.8; 308,925.

ROMANIA, 48–56; 1.2; 2.5: Arad, 2.5; 87,291. Braila, 0.9; 95,514. Bucharest, 2.1; 1,041,807. Cluj, 3.4; 117,915. Constanta, 3.0; 78,586. Craiova, 1.7; 84,574. Galati, 2.2; 80,411. Iasi, 2.3; 94,075. Oradea, 2.3; 82,282. Ploesti, 2.3; 95,632. Sibiu, 4.9; 60,602. Stalin (Brasov), 4.9; 82,984. Timisoara, 3.0; 111,987.

YUGOSLAVIA, 48–53; 1.4; 3.1: Belgrade, 3.8; 389,114. Ljubljana, 1.7; 127,050. Sarajevo, 2.6; 118,806. Skoplje, 5.6; 91,491. Zagreb, 2.2; 326,267.

OCEANIA

AUSTRALIA, 47–54; 2.4; 2.3: *Adelaide*, 3.4; 392,112. *Brisbane*, 3.2; 402,030. *Melbourne*, 2.0; 1,275,525. *Newcastle*, 1.9; 227,488. *Perth*, 3.5; 272,528. *Sydney*, 2.0; 1,626,083.

* 1950 M.A. populations for *Katowice–Zabrze–Bytom* (*Upper Silesia*), *Lodz*, *Walbrzych*, and *Warsaw* are I.U.R. estimates.

HAWAII, 40–50; 1.7; 3.1: *Honolulu*, 3.1; 258,256.
NEW ZEALAND, 51–56; 2.3; 2.2: *Auckland*, 3.0; 348,044. *Christchurch*, 2.1; 179,143. *Dunedin*, 0.8; 103,208. *Wellington*, 1.6; 214,943.

U.S.S.R.

U.S.S.R., 39–59; 0.5; 1.9: Akmolinsk, 5.2; 32,000. Alma-Ata, 3.4; 222,000. Andizhan, 2.1; 85,000. Angarsk (1939 figure not reported; 134,000 in 1959). Anzhero-Sudzhensk, 2.5; 69,000. Arkhangelsk, 0.1; 251,000. Armavir, 1.4; 84,000. Ashkhabad, 1.4; 127,000. Astrakhan, 0.7; 254,000. Babushkin, 2.3; 70,000. Baku (including suburbs), 1.1; 775,000. Barnaul, 3.7; 148,000. Belovo, 4.3; 43,000. Berezniki, 3.5; 51,000. Biysk, 2.9; 80,000. Bryansk, 0.8; 174,000. Chelyabinsk, 4.3; 273,000. Cheremkhovo, 3.7; 56,000. Chernovtsy, 1.6; 106,000. Chimkent, 3.5; 74,000. Chita, 1.7; 121,000. Dneprodzerzhinsk, 1.3; 148,000. Dnepropetrovsk, 1.1; 527,000. Dzerzhinsk, 2.3; 103,000. Frunze, 4.0; 93,000. Gomel, 0.9; 139,000. Gorkiy, 1.9; 644,000. Gorlovka, 2.4; 181,000. Groznyy, 1.7; 172,000. Irkutsk, 1.9; 250,000. Ivanovo, 0.8; 285,000. Izhevsk, 2.3; 176,000. Kadiyevka, 1.4; 135,000. Kalinin, 0.9; 216,000. Kaliningrad, –3.0; 372,000. Kaluga, 2.0; 89,000. Kamensk-Uralskiy, 4.7; 51,000. Karaganda, 4.4; 156,000. Kaunas, 1.7; 152,000. Kazan, 2.4; 398,000. Kemerovo, 3.5; 133,000. Khabarovsk, 2.2; 207,000. Kharkov, 0.6; 833,000. Kherson, 2.4; 97,000. Kiev, 1.3; 847,000. Kirov, 2.7; 144,000. Kirovabad, 0.8; 99,000. Kirovograd, 1.2; 100,000. Kiselevsk, 4.9; 44,000. Kishinev, 3.1; 112,000. Kokand, 1.1; 85,000. Kolomna, 1.4; 75,000. Komsomolsk-na-Amure, 4.3; 71,000. Kopeyak, 4.5; 60,000. Kostroma, 1.7; 121,000. Kovrov, 2.0; 67,000. Kramatorsk, 1.0; 94,000. Krasnodar, 2.4; 193,000. Krasnoyarsk, 3.7; 190,000. Krivoy Rog, 3.4; 189,000. Kuntsevo, 3.5; 61,000. Kurgan, 4.6; 53,000. Kursk, 2.6; 120,000. Kutaisi, 2.4; 78,000. Kuybyshev, 3.5; 390,000. Leninakan, 2.3; 68,000. Leningrad (including suburbs), –0.1; 3,385,000. Leninsk-Kuznetskiy, 2.3; 83,000. Lipetsk, 4.0; 67,000. Lugansk, 1.2; 215,000. Lvov, 0.9; 340,000. Magnitogorsk, 3.6; 146,000. Makeyevka, 1.9; 242,000. Makhachkala, 1.6; 87,000. Minsk, 3.6; 237,000. Mogilev, 1.0; 99,000. Moscow, 0.9; 4,183,000. Murmansk, 3.1; 119,000. Namangan, 2.1; 80,000. Nikolayev, 1.4; 169,000. Nizhniy Tagil, 3.6; 160,000. Norilsk, 7.7; 14,000. Novoshakhtinsk, 3.7; 48,000. Novosibirsk, 3.7; 404,000. Odessa, 0.5; 602,000. Omsk, 3.3; 289,000. Ordzhonikidze, 1.1; 131,000. Orekhovo-Zuyevo, 0.4; 99,000. Orel, 1.6; 111,000. Orenburg, 2.0; 172,000. Orsk, 4.5; 66,000. Penza, 2.3; 160,000. Perm (Molotov), 3.4; 306,000. Perovo, 3.9; 63,000. Petropavlovsk, 1.7; 92,000. Petrozavodsk, 3.2; 70,000. Podolsk, 2.7; 72,000. Poltava, 0.5; 128,000. Prokopyevsk, 4.5; 107,000. Riga, 2.6; 355,000. Rostov-na-Donu, 0.8; 510,000. Rubtsovsk, 4.9; 38,000. Ryazan, 3.8; 95,000. Rybinsk, 1.1; 144,000. Samarkand, 1.8; 136,000. Saratov, 2.2; 372,000. Semipalatinsk, 1.7; 110,000. Serpukhov, 0.7; 91,000. Sevastopol, 1.3; 114,000. Shakhty, 1.8; 135,000. Simferopol, 1.4; 143,000. Smolensk, –0.4; 157,000. Stalinabad, 4.6; 83,000. Stalingrad, 1.4; 445,000. Stalino, 2.0; 466,000. Stalinogorsk, 1.7; 76,000. Stalinsk, 3.9; 166,000. Stavropol, 2.4; 85,000. Sterlitamak, 4.8; 39,000. Sverdlovsk, 3.0; 423,000. Syzran, 2.8; 83,000. Taganrog, 0.3; 189,000. Tallin, 2.7; 160,000. Tambov, 2.3; 106,000. Tashkent, 2.5; 550,000. Tbilisi, 1.4; 519,000. Tomsk, 2.6; 145,000. Tula, 1.0; 285,000. Tyumen, 3.1; 79,000. Ufa, 3.6; 258,000. Ulan-Ude, 1.6; 126,000. Ulyanovsk, 3.5; 98,000. Uralsk, 2.2; 67,000. Ussuriysk, 1.8; 72,000. Ust-Kamenogorsk, 7.1; 20,000. Vilnyus, 0.4; 215,000. Vinnitsa, 1.3; 93,000. Vitebsk, –0.6; 167,000. Vladimir, 3.9; 67,000. Vladivostok, 1.6; 206,000. Vologda, 1.8; 95,000. Voronezh, 1.4; 344,000. Yaroslavl, 1.4; 309,000. Yerevan, 4.3; 204,000. Zaporozhye, 2.1; 282,000. Zhdanov, 1.2; 222,000. Zhitomir, 0.5; 95,000. Zlatoust, 2.4; 99,000.

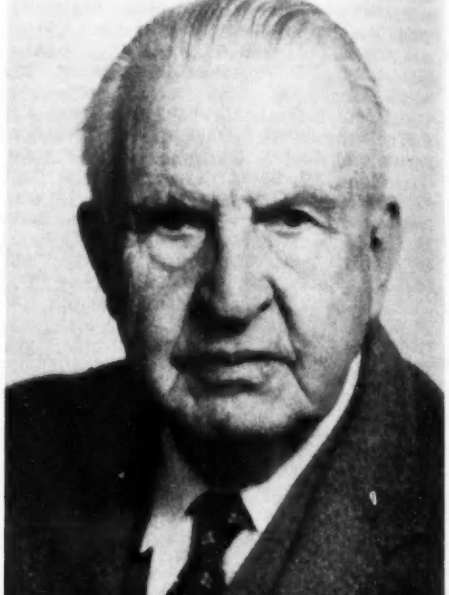
HOMER LEROY SHANTZ, 1876–1958

EVELYN L. PRUITT
Office of Naval Research

A few hours before his death on June 23, 1958, when Homer Shantz took his last look at the Great Plains, he saw not only the grasses that had long held a special place in his interest; he observed also the soil, the roll of the land, the insects and animals, the weather, and the kinds of fences and houses that people build. His broad knowledge and wide experience made him equally at home among geographers, ecologists, taxonomists, conservationists, land planners, and educators, and he was deeply respected by all who knew him. He was one of the few remaining naturalists, men reared in an era when education provided a broad and firm base on which to build a specialty. The foundations of his long, productive scholarly life were laid during his undergraduate years at Colorado College, which he attended after his family had moved to Colorado Springs from his birthplace, Kent County, Michigan. Here arose his interests in the landscape and in the vegetation that exhibited so many fascinating variations. His curiosity and his unquenchable urge to see and understand led him again and again to the periodically drought-ridden High Plains, across the foothills where grasses meet trees, and into the Rocky Mountains. For two years following his graduation in 1901 and his marriage late that year to Lucia Moore Soper from Wisconsin, he continued his studies of the local vegetation in his capacity as Instructor of Biology at Colorado College. This was the groundwork for his dissertation on the vegetation of the mesa region east of Pike's Peak—the culmination of two years of graduate study at the University of Nebraska, where botanical, agricultural, and geographic interests focused on the grasslands.

With his newly won Ph.D., he spent the years 1905 through 1908 teaching botany at the state universities of Missouri and Louisiana. Teaching, throughout his life, was one of his prime pleasures, although for long periods his work took him away from the student contacts he so enjoyed.

His greatest joy, however, came in research. Consequently, he left teaching to accept the



challenges offered by a group of scholars in the Bureau of Plant Industry of the U. S. Department of Agriculture who were trying to develop plants that could survive in the alkaline and droughty environment of our semiarid lands. "Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area" (1911) was the first of a long series of publications that resulted from his studies of dry-land crops. With his frequent collaborator, Lyman J. Briggs, he completed several studies of the factors that affect the water requirements of plants. Their detailed laboratory and field investigations of the relations of soils, weather, plant physiology, transpiration, and wilting characteristics were reported in a dozen articles that have become milestones in botanical research.

At the end of World War I, Homer Shantz

was invited to join a group of technical advisors to the American Commission to Negotiate Peace in their inquiry to determine the natural plant resources and crop producing potentials of Africa and Latin America. This association opened a new chapter in his life and kindled what was to become a life-long interest in all things African. As an agricultural explorer with the Smithsonian African Expedition, August 1919 to September 1920, he travelled by train, automobile, boat, and on foot from Cape Town to Cairo, studying and photographing the vegetation, taking soil samples, noting the animal life, and observing the native agricultural practices. He was impressed by the delicateness of the balance between population pressures and vegetable resources. The first publication of his African work, "Urundi, Territory and People" (1922), was followed by a monograph, co-authored by C. F. Marbut, on "The Vegetation and Soils of Africa" (1923). His second crossing of Africa, this time from Cairo to Cape Town, took place in 1924, when he was a member of the Educational Commission to East Africa, sponsored by the Phelps Stokes Fund, the British Colonial Office, and the International Missionary Council. He reported the results of these expeditions in "Agriculture in East Africa" (1925) and in nine articles on "Agricultural Regions of Africa" (1940–1943). In addition, Dr. Shantz made and carefully annotated many thousands of photographs. This priceless collection, together with his field journals, maps, and manuscripts, are now housed at the University of Arizona.

Although his African studies occupied large segments of his time, the seemingly boundless industry and energy of Dr. Shantz enabled him to produce also his famous paper, "The Natural Vegetation of the Great Plains" (1923), and other papers on desert and semi-arid vegetation. In addition, he wrote with Raphael Zon the section on natural vegetation in the "Atlas of American Agriculture" (1924), and gave lectures at the newly established Graduate School of Geography at Clark University. This partial return to teaching became complete in 1926, when he left the Department of Agriculture to become Professor of Botany at the University of Illinois. However, his preoccupation with teaching and research lasted only two years, and in 1928 Dr. Shantz accepted an appointment as President of the University of Arizona. During eight years in that office his deep appreciation of the value of a liberal education, research, and the arts of teaching were evidenced in the many scholars attracted to his staff. He punctuated his administrative duties with teaching, writing (mainly on land-use planning), and research on the vegetation of the arid Southwest. From these studies came another valuable collection of annotated photographs.

When the demands of administration threatened to cut him off completely from teaching and research, he returned to the U. S. Department of Agriculture, this time as Chief of the Division of Wildlife Management of the Forest Service. Here he turned his attention to the broad problems of generating sound policies and practices regarding the use of natural resources. Long after his retirement in 1944, he continued to write from his home in Santa Barbara earnest pleas for the development of land management systems based on fundamental ecological knowledge.

To help fill the huge void left in his life by the death of his cherished wife in 1954, Dr. Shantz undertook a study of the vegetation changes that had occurred in the plains and the zone of meeting of forest and grasslands in Colorado since his initial studies 45 years earlier. In this effort he was joined by William G. McGinnies. It was while he was so engaged that Carl Sauer brought to the attention of the Geography Branch, Office of Naval Research, the fact that Dr. Shantz, at the age of 80, was eager and prepared to do what few earth scientists can do—repeat earlier studies to define changes precisely. With a deep sense of the honor the occasion presented to O.N.R. to assist one of the world's great scientists, arrangements were made for Dr. Shantz to retrace his African journeys. In August, 1956, he and his associate, Dr. B. L. Turner, botanist from the University of Texas, started the eight months' trek, armed with some 2,000 photographs taken on earlier trips. His letters exuded his happiness at being back at work in Africa. But they also noted his distress at what was happening to the countryside. "Everything natural has been changed." The old practices that had allowed the agricultural tribes to maintain a balance

with nature had been abandoned in favor of almost continuous use of land, and thus its early exhaustion. In cattle raising areas, overstocking was removing almost all vegetation. "There are no definite plans to meet over population of natives, of cattle, of game." The alarm expressed in his letters was recorded only in small part in his "Photographic Documentation of Vegetational Changes in Africa Over a Third of a Century" (1958), because he planned to write other articles on the misuse of African lands.

Cheered by the success of his African documentation study, and while the report was in press, Dr. Shantz, again with O.N.R. support, began a similar study in the Northern Great Plains. With him was Dr. Walter S. Phillips, botanist from the University of Arizona. In the midst of this work, and surrounded by the grasslands he knew so well, death overtook this great man of wisdom, sensitivity, and gentleness.

Among the many honors bestowed upon him was the A.A.G. Outstanding Achievement Award (1954). His complete bibliography is so lengthy that only selected publications most familiar to geographers can be cited here.

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HARLAN H. BARROWS, 1877–1960

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HARLAN H. BARROWS' life spanned the final quarter of the Nineteenth Century and six decades of the Twentieth. In large measure this period witnessed the development of academic and professional geography in America. To this development he contributed high standards of geographical research, an amazing talent for logical organization, notable clarity of expression, and both constructive and, at times, devastating criticism. Tall (6 feet, 5 inches) in stature, erect in posture, and endowed with exceptional intellectual qualities, Barrows was a man, "every inch of him." He was admired, respected, and feared, depending on the situation and circumstances under which people knew him. Many sincere and ambitious students profited greatly in their contacts with Barrows, as did professional colleagues fortunate enough to work closely with him.

Professor Barrows was born in Armada, Macomb County, Michigan, on April 15, 1877. He was the son of a prominent family in this eastern Michigan village largely settled by families from New England and "upstate" New York. As a boy, Barrows was a great reader, especially of history and biography. At the age of fourteen, he graduated from high school and at nineteen from the Michigan State Normal College. His eager mind, his extraordinary memory, and his ability to concentrate through long hours of study made him a conspicuous student.

After finishing at the State Normal College, Barrows taught geography and history at Ferris Institute, a frontier institution at Big Rapids near the southern border of the Michigan woods. It was designed for young men and women who wanted some technical training or who needed to make up work in preparation for college. Isaiah Bowman attended the Institute and was one of Barrows' students. Here began a life-long friendship of two of the great minds of Twentieth Century geography. While he was in Big Rapids, Barrows married Janie E. Gleason on August 16, 1898. They had one son, Robert Harlan, whose accidental death in 1919 was a major blow to Barrows. Mrs. Barrows had died July 23, 1913.

In 1903, Barrows took his B.S. degree at the University of Chicago where Chamberlin and Salisbury were making history in the earth sciences. The former had left the presidency at the University of Wisconsin to establish a department of geology in the new University of Chicago. Salisbury became Professor of Geographic Geology and later (1897) was appointed Dean of the Ogden Graduate School of Science. In 1903, the University established the first university department of geography in America. Salisbury became head of the new department and Barrows was one of the early students. The latter's work as student and assistant was so outstanding that in 1907 he was appointed instructor of geography. Thus began a close association with Salisbury in teaching, research, and writing, an association that resulted in many constructive contributions to geography. Among them, their college textbook, *Elements of Geography*, with W. S. Tower as co-author, provided introductory

ideas and materials for use in the many colleges and universities to which geographic teaching spread in the early decades of this century.

In 1906–1907, Barrows undertook for the State Geological Survey a study of the Middle Illinois River Valley. The completed study was published in 1910 as Bulletin 15, *The Geography of the Middle Illinois Valley*. In transmitting this volume to the State Commission, Frank W. DeWolf, acting director of the survey, wrote, "A final Chapter . . . describes the settlement and development of the Peoria-Hennepin region from the time of the pioneers who emigrated from the South and from New England. The distribution of the early population, its conquest of adverse conditions and final development into a community of great interests, is skilfully traced." In this bulletin, Barrows displayed a characteristic style, as for example in the following oft-quoted sentence: "Every important river town in the area is situated upon the edge of a terrace against which the river swings, and every such terrace has a town."

After his first appointment in the Department of Geography, Barrows moved rapidly up the academic ladder to reach his professorship in 1914. On September 4, 1915, he married Adda B. Weber. They had two children—Dorothy Elizabeth and Jean.

Probably no American geographer contributed more in the establishment of high geographic standards at the graduate level than did Barrows. This was demonstrated in the winter of 1914, when a graduate seminar was offered as a departmental enterprise. All the staff (Salisbury, Goode, Barrows, and Tower) and all graduate students attended. The presentations, discussion, and criticisms added much to the advancement of geographic thought and the refinement of methods and techniques of research and writing. Each member of the seminar helped to shape the extremely active discussions, but it soon became apparent that in many respects Barrows led the way.

From the beginnings of his university work, Barrows maintained an interest in the interrelations of geography and history. In 1904, somewhat against Professor Salisbury's advice, Barrows first offered what was to become one of the famous courses of the Department and the University. At the outset he called the course *Influence of Geography on American History*. Although this first title represented the thought of the period, in time Barrows became increasingly dissatisfied with the title and the approach it represented. Hence, in 1923, the title became *Historical Geography of the United States*. His change of thought is well-stated in his presidential address before the Association of American Geographers (1922). In referring to the trends of geographic thought from 1903 to 1922, he wrote:

> Scarcely was physical geography established, or perhaps I should say rejuvenated and re-established, before an insistent demand arose that it be "humanized." This demand met with a prompt response, and the center of gravity within the geographic field has shifted steadily from the extreme physical side toward the human side, until geographers in increasing numbers define their subject as dealing solely with the mutual relations between man and his natural environment. By "natural environment" they of course mean the combined physical and biological environments.

This course as it developed attracted students from other departments. Hence, it helped greatly in cultivating a favorable attitude in regard to the role of geography in higher education.

As his work matured, Barrows increasingly sought accuracy in his reasoning and clarity in his expression. He wanted to state a thesis so effectively that he could defend his interpretations and justify his conclusions. He argued that "a motivating theme, an organizing concept, is required which shall permeate geography and give to all its divisions a distinctive point of view." He thought that to be truly geographic a discussion must involve from beginning to end an explanatory treatment in orderly sequence of "the mutual relations between men and the natural environment of the regions or areas in which they live." At another point in his definition of geography as human ecology, he states, "It is not the human fact which is geography, any more than it is the environmental fact, but rather the relation which may exist between the two. . . . Geography is a science of relationships." In another place, he states that geographers in the future will take as the objective of geographic inquiry "man's adjustment to environment rather than that of environmental influence." Hence, he argues that "the former approach is more likely to result in the recog-

nition and proper evaluation of all the factors involved and especially to minimize the danger of assigning to the environmental factors a determining influence which they do not exert."

Early in his career, Barrows became interested in conservation—a movement propelled into public attention by such virile figures as Theodore Roosevelt, Gifford Pinchot, and President Van Hise of the University of Wisconsin. Barrows introduced a course in this field at the University of Chicago—an offering which has been copied in many colleges and universities. Although for a time public interest in the movement waned, Barrows continued his vigorous cultivation of the field. Gradually he developed deep convictions as to the questions at issue and the policies, state and national, which should be adopted. These ideas and convictions shaped his later career in the utilization of water resources.

His first major public service came during 1918, when he was head of the country section of the Bureau of Research, U. S. War Trade Board. There, his honesty of purpose, his depth and breadth of knowledge, and his powers of reasoning won him wide recognition.

Barrows became Chairman of the Department of Geography in 1919 and continued in that capacity until he became professor emeritus in 1942. The appointment was occasioned by the retirement of Professor T. C. Chamberlin, for many years Head of the Department of Geology. To fill this vacancy, the University administration asked Salisbury to move to the headship of Geology and Barrows to become chairman of Geography. Barrows approached the chairmanship with his customary zest for the work at hand. In order to broaden the outlook of the staff and students, he inaugurated a policy of inviting some distinguished European geographers to lecture during the Summer Quarter. The list included L. Rodwell Jones, London; Helge Nelson, Lund; Baron Sten DeGeer, Stockholm; Raoul Blanchard, Grenoble; and Patrick Bryan, Leicester. These eminent visitors in their contacts with students and staff not only stimulated interest in European geography and geographers, but demonstrated the value of geographic understanding in international affairs.

About 1923, Barrows and Edith P. Parker began the preparation of a series of textbooks for the elementary schools. At that time, Miss Parker was on the staff of the University Laboratory School and had experimented with new ideas and methods in the teaching of geography. Barrows on his part had reached the conclusion that better teaching at the elementary levels would have an invigorating effect on geographic thinking and teaching at the higher levels. In harmony with their ideas, the authors adopted a single-cycle, carefully graded organization that broke with the two-cycle organization in common use at that time. They produced instead a four-book series beginning with a fourth-grade book entitled *Journeys in Distant Lands*. Throughout the series, carefully directed study of special purpose maps and pictures made these materials basic in the work. The finished series stimulated discussion and produced the hoped-for invigorating effect on the teaching of geography.

Professor Barrows was appointed a member of the Mississippi Valley Committee of the Public Works Administration in 1933. This committee was established by Harold L. Ickes, who was Secretary of the Interior and Administrator of P.W.A. With this appointment, Barrows entered into a new phase of service; his interest shifted from academic management to national policy. Although he kept a foot in the department affairs, his major thrust of activity thereafter was on the Federal scene. As a member of the Ickes committee, headed by Morris L. Cooke, Barrows first took part in a review of proposed public works projects in the Mississippi Valley and then began to concentrate upon preparation of a comprehensive plan for water resources development.

By 1934, the preliminary plan had been published as the Committee's report, and the Committee entered into a series of transformations under the changing tents of successive national planning agencies. Members of the Mississippi Valley Committee became the Water Planning Committee of the newly created National Resources Board, and with various replacements, the Water Resources Committee of the National Resources Planning Board. Barrows was on all these groups, resigning from the Board in 1941.

Professor Barrows' contributions on the na-

tional scene were of three major sorts. While a member of the national water planning committees, he insisted upon exacting standards of writing for the public reports which poured out. His style was direct, accurate, unequivocal. He slashed the Federalese, the sodden engineering description, and the politically ambiguous prose that came within his reach. His prodigious work schedule and demanding editing earned him the affectionate title of "Mister Legree" among the lower echelons. He encouraged and strongly supported the younger men, but his inflexibility also alienated some of them. Sherman Woodward, the master hydraulician, refused to study the Lower Mississippi unless Barrows would join him and write a characteristically forceful report, and between them, combining engineering and geographic analysis, they effectively challenged the then-prevailing policy of Mississippi River control. The results of such craftsmanship are recorded in the basic reports of the Mississippi Valley Committee, the National Resources Board, the National Resources Committee, and the National Resources Planning Board. Some of those to which Barrows made conspicuous contributions are listed in the bibliography.

In the course of committee discussions and editing, Barrows played an influential role in shaping expressions of the emerging national policy of multiple-purpose river development. He gave clarity and precision to thinking that had been current but confused since the days of the Inland Waterways Commission. Many of the strong passages on the importance of integrated planning and balanced use of water resources in the national interest are from Barrows' pen, and have been used so often thereafter that they appear hackneyed to the uninitiated. His drafting hand also was an influential factor in the shaping of new Reclamation legislation, including the Wheeler-Case Act and the Act of 1939. The Great Plains drought reports of 1936 and 1940 reflected in considerable measure his view of policies needed to cope with climatic variability.

The most influential contribution by Professor Barrows was in the design of integrated regional studies. Here, he added a new dimension to Federal-State investigations, carrying the broad concepts which Major John Wesley Powell had enunciated fifty years before into concrete and sophisticated study programs. The first of these efforts was the Rio Grande Joint Investigation. With the able collaboration of Frank Adams, Barrows was the architect of the scheme which, in order to obtain water and land data deemed necessary to successful negotiations of a compact among Colorado, New Mexico, and Texas for the allocation of Upper Rio Grande waters, brought together Federal agencies and State agencies in a three-year program of investigations, 1935–1938. More than $2,000,000 was expended on work which was summarized in the National Resources Committee report, and which led to the conclusion of a compact. Throughout the period of the studies and of the compact discussions, Barrows, as the impartial N.R.C. consultant, drove hard for agreement and action; he knocked bureaucratic heads together, attacked the usually sacrosanct Comptroller General's Office, and sat through endless sessions of agency representatives. His general technique was to seek for agreement by all interested parties on the questions to be resolved, then to outline ways in which answers might be obtained, and to push hard for funds and good will to get those answers.

The Pecos Joint Investigation, 1939–1941, and the Red River of the North report resulted from application of this method, but the monumental demonstration of it was the Columbia Basin Joint Investigations which Barrows headed up for the Bureau of Reclamation. He probably had more influence upon thinking about the impacts of water projects in the Columbia Basin than in any other area, but his thinking was felt in all phases of irrigation planning.

In subsequent years, the report of those investigations shaped technical analysis of water projects over many other areas. Moreover, the list of questions posed for investigation still is an incisive classification of resource-use problems in an irrigated area. His outline for the investigations became the springboard for studies and policy discussions cutting across all the relevant disciplines and levels of jurisdiction. He continued the same type of analysis as a consultant to the Department of the Interior concerned with resource develop-

ment problems in Alaska and in the Central Valley of California.

By 1958, the man who had joined vigorously in F.D.R.'s New Deal was unhappy with the liberalism of Dwight D. Eisenhower, and while he maintained cordial correspondence with a few of his younger associates who had shared in the earlier crusade, he regretted their persistence in staying on what was now the wrong route of big government and Federal spending. Hence, he cut himself off from many of his admirers. However, if he felt the isolation of retirement, he was too proud and shy to admit it. Always in command of his immediate situation, and always clear as to his next step, Professor Barrows took leave of this life on May 15, 1960, as though on the same kind of schedule he had followed so long.

In conclusion, it becomes clear that the vigorous intellectual contributions of Harlan H. Barrows not only helped to define and illuminate the development of geography as a field of learning, but also exercised a constructive impact on the recognition of the principles of water utilization and the design of integrated regional studies.

Professor Barrows possessed knowledge based on careful and systematic evaluation of both the assets and liabilities of the American scene. His acute sense of problem enabled him to pose critical questions for investigation. Moreover, his analytical faculties led him step by step through the mass of materials relevant to the problems under review. Finally, he generated conclusions formulated from extensive knowledge and understanding of basic considerations.

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LETTER TO THE EDITOR

Mon cher Collègue,

Après avoir lu l'ouvrage de M. K. A. Wittfogel [*Oriental Despotism: A Comparative Study of Total Power* (New Haven: Yale University Press, 1957)], et l'excellent compte rendu par M. Theodore Shabad, de diverses appréciations de cet ouvrage [*Annals*, Vol. 49 (1959), pp. 324–325], après avoir lu l'article que mon collègue et ami M. O. H. K. Spate lui a consacré [*Annals*, Vol. 49 (1959), pp. 90-95], je me sens entrainé à exposer quelques vues personnelles sur ce livre. Je le fais avec hésitation car j'ai beaucoup d'estime et d'admiration pour M. K. A. Wittfogel, mais je ne puis me ranger aux vues qu'il a exprimées dans son récent ouvrage, et je ne puis non plus approuver les avis que M. O. H. K. Spate a portés sur ce livre. Je me résigne donc à vous écrire ces quelques mots parcequ'il est dit, au terme de l'excellent compte rendu de Shabad, que peu de recenseurs occidentaux "questioned the basic validity of the concept of hydraulic despotism." Je voudrais, si vous estimez ces quelques remarques dignes d'être publiées, dire qu'il y a des Occidentaux qui, sans être marxistes, ont lu avec étonnement le livre de M. K. A. Wittfogel et n'ont pas été moins étonnés de l'engouement qui a saisi divers recenseurs anglo-saxons.

Voici, très rapidement exprimées, les réserves que je fais sur l'"Oriental Despotism" de notre très honorable collègue et ami M. K. A. Wittfogel:

(1) Cette notion d'"Oriental Despotism" est une notion vague; j'éprouve de la répugnance à classer dans le Despotisme Oriental des régimes aussi divers que ceux de la Chine, de l'Inde, de l'Asie occidentale, de l'Egypte. Pour ce qui est de la vieille Chine j'aurais personnellement tendance au contraire à mettre l'accent sur les *institutions* et leur formalisme et non sur le despotisme. Qu'est-ce qu'un despotisme sans despote?

(2) Pour la Chine le livre de M. K. A. Wittfogel a des bases erronnées: (a) dans la Chine du Nord l'agriculture était et reste fondamentalement une agriculture sèche. Les champs de kaoliang du Tche Li, les champs d'orge et de blé du Chen Si n'ont jamais été irrigués, malgré l'aridité du climat. L'irrigation a été en Chine du Nord un raffinement et non pas une nécessité. De toutes façons, hors certaines vallées privilégiées comme celles de la Wei ou du Hoang Ho, l'agriculture de la Chine du Nord est restée une agriculture sèche. Quant à la protection contre l'inondation, qui est une autre forme de l'hydraulique, elle intéressait seulement une petite partie des terres cultivées de la Chine du Nord. La plus grande partie, et la plus ancienne, était située sur des terrasses loessiques qui ne redoutaient pas l'inondation. (b) Dans la Chine centrale, autre tableau, et non moins incompatible avec la thèse de M. K. A. Wittfogel. Ici la plus grande partie des terres cultivées est inondée, tout au moins en saison des pluies (c'est-à-dire en été). Mais ces rizières inondées reçoivent leur eau directement de la pluie du ciel; l'homme aide à l'inondation, quand c'est nécessaire, par de l'eau qu'il prélève, au moyen d'écopes et de norias, dans les fossés, dans les mares, dans les fleuves. Mais, sauf exception, ce travail se fait par initiative individuelle, sans intervention d'un despotisme d'Etat, et sans travaux de l'Etat. Il y a des exceptions, bien sûr, mais ce sont des exceptions. Quant à la protection contre les inondations je dirai ici encore qu'elle intéresse seulement une partie des terres cultivées et, en second lieu, qu'elle pouvait être assurée par de médiocres travaux de caractère local.

Voilà donc, très simplement exposées, les raisons pour lesquelles j'estime que la thèse de M. K. A. Wittfogel n'a pas de base dans les conditions naturelles. Bien entendu, les conditions naturelles sont autres dans la vallée du Nil: mais je ne parle pas ici de l'Egypte, qui n'est d'ailleurs pas au point de départ des vues de M. K. A. Wittfogel.

(3) La nécessité d'une hydraulique collective stricte s'est imposée très fortement aux Pays-Bas. Pas de polders sans hydraulique collective et disciplinée. Où est le despotisme "oriental"?

(4) Ma conclusion est la suivante: le travail de M. K. A. Wittfogel est inquiétant à plusieurs titres. Il est inquiétant parce que l'apparente rigueur de la démonstration, appuyée sur une terrible terminologie, risque de faire croire à la réalité de la chose qui est à démontrer. Il est inquiétant parce que, malgré les précautions de l'auteur, il est en fin de

compte une réintroduction du déterminisme physique dans les domaines de l'histoire et de la géographie; par là il est à l'opposé d'un progrès scientifique. Il est inquiétant parce qu'il a l'ambition de schématiser le divers et par là de stériliser la réalité. Il est inquiétant enfin parce que son titre, en faisant un emploi malheureux du mot oriental, d'une part soulève la juste susceptibilité des "Orientaux" et, d'autre part, donne à croire que l'Orient est autre chose qu'une expression géographique.

Je vous prie d'accepter, mon cher Collègue, l'expression de mes sentiments les meilleurs.

PIERRE GOUROU

Collège de France, Paris et Université Libre, Bruxelles

ABSTRACTS OF PAPERS PRESENTED AT THE 57TH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS EAST LANSING, MICHIGAN, AUGUST 28–SEPTEMBER 1, 1961

JOHN Q. ADAMS—*Building Types in Western and Southern U.S.S.R., Similarities and Contrasts*

Observations and pictures made during the Geographers Tour of Western and Southern U.S.S.R. in 1960 revealed that there are many similarities between the forms of new houses in various parts of the country. There is wide variation, however, in building materials, construction techniques, and workmanship in houses. Public buildings such as office buildings, markets, and recreation centers vary widely in form as well as materials due to the multiplicity of type. In spite of the highly centralized control of the building industry, individual variations appear from time to time as is shown in the Rostov-on-Don municipal auditorium which has the form of a track-laying tractor.

S. REZA AHSAN—*Gainesville's Northern Fringe: A Geographic Study of a Multiple Use Suburb*

Gainesville was incorporated as a city in the year 1889. Since the establishment of the University in the early part of this century the town has been growing steadily. The expansion of the University just after World War II and the introduction of industries led to the rapid growth of the city. The suburban fringes of Gainesville are also growing very rapidly. The economy is being diversified. The resultant thrust on the suburban lands has been great. Since the city does not have the authority to zone its suburbs, the growth has been not wholly on a planned basis.

Land-use maps have been plotted by the use of aerial photographs of the area and supplemented by field reconnaissance. The total area under observation is 1,790 acres. The following categories of land use have been delineated: (1) residential, (2) industrial, (3) commercial and industrial, (4) business, (5) woodland—pines and scrubs, (6) woodland—hardwood.

A discussion of communication, public utilities, recreation and amusement, land values, population, and industries treats the various aspects of micro-economic geography.

JAMES R. ANDERSON—*Toward More Effective Methods of Obtaining Land-use Data in Geographic Research*

The collection of land-use data by using both enumeration and observation methods or a combination of these two methods has been carried out by different researchers and by various data collection agencies. When data collected by one method are compared with those obtained by another, erroneous conclusions may result. Numerous definitional problems exist in developing categories of land use which will permit the collection of repeatable data. It appears that a combination of observational and enumeration methods will permit a refinement of definitions of land-use categories.

Recently the U. S. Department of Agriculture completed a comprehensive national inventory of soil and water conservation needs. This inventory has made a distinct contribution to the collection and analysis of land-use data. For the first time information on soil type, slope, erosion condition, and land use are systematically available for the same areal unit in such a way that by use of electronic computers these data on physical conditions and land use can be compiled and analyzed for different natural, economic, or political units of the country.

However, this inventory did not use the combined approach of observation and enumeration in the collection of land-use data. If such an approach had been used after carefully tested definitions had been developed, then this inventory would have provided a more satisfactory answer to some of the difficult problems in the collection of land-use data which are discussed in this paper.

JOHN P. AUGELLI—*The Rimland–Mainland Concept of Culture Areas in Middle America*

"Middle America" is an arbitrary geographic expression which frames a loosely ce-

mented mosaic of peoples, places, and cultures. Mexico, Central America, and the West Indies, to which the term is normally applied, share in common a general focus on the Gulf and Caribbean Sea, an intermediate location between North and South America, and not much of anything else. The interplay of a varied physical environment with pre-Columbian patterns and post-Conquest evolution in these areas has made a somewhat different composite of people, habitat, and cultural tradition of almost every island and mainland nucleus of settlement, and the resulting complexity of "culture areas" defies facile classification.

This paper presents a scheme of culture-area classification whose point of departure is the division of Middle America into a "Euro-African Rimland" consisting of the West Indies and the Caribbean coast of Central America and a "Euro-Indian Mainland" which is made up of the remainder of Central America and Mexico. The division is supported in part by differences in race, habitat, and cultural orientation but more especially by the institutional play of the coastal "plantation" and the interior "hacienda."

A subdivision of the Rimland recognizes the essential differences between the Antillean and the Central American sectors as well as the cultural impact of various national influences such as British, French, Dutch, Hispanic, and Anglo-American. The Mainland is divided into three sectors — "Mesoamerican," "Mestizo," and "European"—based upon the arrangements of racial factors and cultural forms.

HARRY P. BAILEY—*On Recognition of Temperate Climates*

In our lifetime, the domain of the temperate climate has shrunk in geographic writing from all the area between the Tropics and Circles to small and isolated regions with irreproachably mild thermal regimes—a great contraction based on the protest that midlatitude location does not guarantee freedom from climatic extremes. That protest was not backed with systematic quantitative reasoning, however, and so a question remains whether undue restriction has not been placed upon the areal limits of climates properly called temperate.

A method has been established to estimate the magnitude of departures from an origin assumed to represent a thermal level ideally temperate, 14°C (57.2°F), a choice supported by its close approximation to the average annual temperature of the earth, and its position midway between the thermal limits to polar and tropical climates as those limits have been assigned by Koeppen, and others. Departures from that origin are expressed in a scale of temperateness varying from zero value in the complete absence of mild temperatures, as found in Antarctica, to an index of 100 where temperatures prevail at 14°C, a condition approached in certain tropical plateaus.

Maps of the distribution of differing degrees of temperateness have been prepared for the world, and in greater detail for the United States. They show general agreement with current ideas about the distribution of climates pronouncedly temperate in character, but add to that pattern areas closer to the threshold of temperateness, such as the southeastern United States, and certain of the Arizona highlands. The maps suggest that the domain of the temperate climate should be expanded, and that by so doing better agreement may be possible with the distribution of mesic floras, and also with human reactions to climatic comfort.

JOHN R. BORCHERT — *The Growth of Small and Medium-sized Cities in Minnesota and Western Wisconsin*

Average decennial percent growth rate and average inter-decennial variability of growth rate has been determined for the urbanized area population of ninety-nine small and medium-sized cities in Minnesota, western Wisconsin, and certain adjoining counties of the Dakotas. The result is an expression for the rate and steadiness of population growth for each place. The towns have been divided into nine groups based upon negative or slow, moderate, and fast growth rates and low, medium, and high degrees of unsteadiness of growth. It is determined that small city growth in this part of the Midwest is generally quite unsteady, and short-term variations in growth tend to be only slightly related to city size or national average trends. Cities typed according to their long-term characteristics of growth rate and steadiness are region-

ally and functionally differentiated. However, growth types based upon these measures are more clearly related to regional locations than to present functions of the cities. Net long-term urban growth is also related to site and location factors of mainly historical importance. Site, location, and growth appear to be important and interrelated characteristics of the cities studied; and it is recommended that classification schemes based upon those variables could be applied profitably to American cities.

DIETER BRUNNSCHWEILER—*Synoptic Climatology of Michigan*

It is the purpose of this study to explain the seasonal climatic regime of Michigan on the basis of the synoptic behavior of the atmosphere in the Great Lakes region. Eleven synoptic types ("Gross-wetterlagen") were found to have determined the weather pattern in Michigan in the mid-season months of the pentad 1953–1957. Cyclonic types occurred more frequently than anticyclonic types in winter and spring, while the reverse was true in summer and fall. For the whole period anticyclonic types were more numerous than cyclones.

The normal (long period distribution of temperature and precipitation) of the mentioned period was then analyzed in terms of synoptic type frequencies. Lows of western and southern origin with open mT-warm sectors are responsible for the marked spring rain peak in southern Michigan. The mid-summer slump of rainfall, observed at all stations of lower Michigan in most years, is clearly connected with a high frequency of surface highs. The "lake effect" is most noticeable with anticyclonic control in fall and winter in western lower and northern upper Michigan where the relief effect some distance inland is sufficient to trigger occasionally heavy snowfalls from unstable cP air. Even in the "snow belt" of southwestern Michigan, however, most of the winter snowfall can be attributed to frontal activity.

Variations in the frequency of individual synoptic types account for deviations of element values from normal. Generally, high anticyclonic frequency produces negative departures for both temperature and precipitation. Above-normal conditions are almost exclusively the result of increased cyclonic activity.

KARL W. BUTZER — *Remarks on Soil Erosion in Spain*

The mediterranean climatic zones are generally thought to be the most characteristic areas with accelerated soil erosion, and in the Mediterranean Basin the widespread denudation of all upland surfaces in moderate or steep slope is considered the product of deforestation and overgrazing in historical times. On the basis of pedological, geomorphological, and stratigraphical evidence from two *Csa* climate zones of Spain, viz. Mallorca and Catalonia, the general validity of this simple interpretation is questioned.

Well-dated Postglacial climax soils (xerorendzina or meridional *Braunerde* types) are described and compared with fossil or buried *terra rossa*, *terra fusca*, *Braunlehm*, and *Rotlehm* soils of interglacial age. These strongly support the emerging opinion that the Mediterranean plastosols are relict or fossil. These soils are also fundamental in stratigraphic considerations.

Closer examination of the Mallorcan sierras indicates that the denudation of the once-existing soil cover is predominantly pre-Upper Pleistocene in date, and no part of historical age. Modern land-use phenomena are indicated in explanation, and the quasi-absence of modern geomorphic processes, outside of the high sierras, is considered fundamental for Mallorca.

In Catalonia there is evidence of both fossil, Pleistocene denudation of soils and, locally, of historical accelerated erosion whose beginnings are dated between 256 and 400 A.D. Cultural reasons for these very temporary features of mass slope downwashing are outlined.

In conclusion it is suggested that soil erosion phenomena in the Mediterranean Basin are deserving of considerably closer investigation.

HANS CAROL — *Alternative Concepts to the Urban Sprawl*

Urban geography is usually interpreted as the study of urban phenomena, starting at the time of their origin and ending with the present. However, theoretical knowledge thus

gained can be applied practically for forecasting current trends; moreover, knowing the role of specific factors of urban growth, other combinations of these same factors can be suggested, thus leading to different patterns of urban development.

It is generally agreed that the increase in population of the next decades will be concentrated almost exclusively in metropolitan areas. For some 50 million people new homes and working places have to be provided. Where should they be located? The current trend of "urban sprawl" will most likely continue in the decades to come, leading to what C. Feiss has called "total pollution of metropolitan areas."

Basic elements of future growth, namely central functions, manufacturing, and population, could, however, be combined and located in different ways, thus leading to new types of settlements: "residential satellites," "industrial towns," and "regional centers." Such concepts as well as combinations of them will be explained in the paper as alternatives to the urban sprawl.

Today, concepts like these may be of theoretical interest only. However, as dissatisfaction with the urban sprawl increases such ideas may serve as guideposts to more meaningful forms of urban growth.

MARTHA CHURCH — *Functional Duplication and Diversity in a Twin Cities Area: Benton Harbor and St. Joseph, Michigan*

In the later part of the 19th century, St. Joseph businessmen developed a number of overland and lake transportation facilities and industrial concerns along the north side of the St. Joseph River. The labor force attracted by these activities varied greatly from that associated with St. Joseph not only in national origins but also in religious heritage. Such variations played an important part in the development of two municipalities in an area which normally would have developed as one urban area. Thus in 1891, St. Joseph and Benton Harbor received city charters even though some of the leading citizens of both villages had led a valiant campaign to unify the two villages and have them incorporated as one city.

This paper analyzes the internal structural and external relations of this twin cities area which is noted for deliberate duplication of functions as well as a considerable amount of economic diversification.

JAMES I. CULBERT—*Manufacturing Industries of Juarez, Mexico*

Ciudad Juarez, the largest city on the Mexican border, and the fourth largest in Mexico, lies across the Rio Grande from El Paso, Texas. Juarez, the original Paso del Norte, is located on the south bank of the river where it cuts through a saddle in the mountains, making the famous Pass to the North. The settlement was an important stopping place on the Camino Real between Mexico City and Santa Fe, but grew slowly because of its isolated location.

With the coming of railroads Juarez became an outlet for Mexican lumber, ore, and cattle and the most important port of entry on the border. In recent years, it has become an important tourist center, and its proximity to El Paso and U. S. defense installations has increased business and population greatly. Its most important function is as a resort.

Industry is poorly developed in Juarez, and the number employed is small in comparison to the population. The principal industries are meat packing, cottonseed oil refining, brick and tile, and steel. Distilling is also noted. Except for the cotton oil industry, the best developed appear to be those which enjoy some market in the United States.

The growth of this city has been due in large measure to its close relations with the United States. Its industry and population will probably grow in concert with the growth of the neighboring parts of the United States, providing that no economic barriers are set up and that the political climate between the two nations remains friendly.

LESLIE CURRY—*Some Elements of a Random Spatial Economy*

The value of queue theory in analyzing general locational problems is remarked. By its use, the traditional regular distribution may be discarded and more information than previously obtained in probabilistic terms. Some features of areal randomness are discussed. Central place theory is phrased in terms of queuing and a market structure developed using a geometrical probability no-

tion. The relevance of queue theory to industrial location is suggested, thus providing a possible means for developing a general theory of areal economic structure. The use of the hyper-exponential and Erlangian sets of distributions would allow distributions other than random to be analyzed.

RICHARD E. DAHLBERG — *Evolution of Interrupted Projections*

World map projections characterized by internal interruptions may be grouped into two classes on the basis of symmetry. One class divides the map into segments of uniform size, irrespective of the continuity of either the continents or of the oceans. This class is found on maps dating from the 16th century and bears the impress of symmetry. The other interrupted form, developed more recently, is characterized by an unsymmetrical design which preserves the unity of the continents by carefully adjusting the position of the interruptions.

In general, the development of the latter type of interrupted projection has been attributed to American cartography. Some have credited it specifically to Professor J. Paul Goode, whose projection designs exhibit many interesting features. They are contiguous arrangements of separate graticules, each developed about a mid-meridian drawn through the center of a continent. Accordingly, the voids which result from joining reverse-curving segments interrupt the oceans. Such a design represents the acceptance of interruption as a compromise to improve other qualities, but a rejection of symmetry.

A careful examination of maps produced during a resurgence of interest in the world map, near the beginning of this century, reveals that a number of investigators in Europe were also prepared to subordinate design to function. Though they produced projections with adjusted interruptions prior to those of Goode, their designs were not widely adopted.

GEORGE F. DEASY—*Pennsylvania's Bituminous Coal Strip Pits as Sites for Sanitary Landfills*

An acceptable method of disposing of waste materials from urban centers is a growing necessity if the public is to be properly served. Interest is centering to an increasing extent upon the sanitary landfill process of waste disposal, because it is low in initial and maintenance costs and at the same time meets all standards of health, safety, and esthetic acceptability.

Abandoned bituminous coal strip pits lend themselves admirably to such a process, and urban centers in western and central Pennsylvania should fully utilize the many opportunities afforded by accessible pits as foci for accumulation of waste. Such use offers the additional advantage of providing a cost-free method of removing some of the scars of earlier stripping operations from the Pennsylvania landscape, and may enable some cities and towns to acquire valuable urban, suburban, and industrial land sites that can be employed for community purposes or sold for profit.

This study is an initial survey of the opportunities for employment of strip pits as sanitary landfill sites by the scores of urban centers in the western and central parts of Pennsylvania.

ARTHUR H. DOERR—*A Preliminary Survey of Plant Succession on Coal Mine Spoil in Oklahoma*

Man is a significant modifier of the physical environment as well as a creator of the cultural. The cultural act of coal mining is especially important in disturbing the extant natural environment. Land-form modifications in stripped regions are obvious, and, while underground mining yields more subtle changes, such changes do occur. Stripping overturns bedrock and mature soils, reversing in a few months the soil-forming processes of centuries. The biotic community is greatly disturbed or destroyed, especially in strip-mining regions, and significant new ecological adjustments are set in motion.

In Oklahoma a great variety of geomorphic, edaphic, and biotic environments have been created by coal mining. Variations in terrain, soil types, and biotic communities before stripping provide a broad sampling base for examination of the physical impact of mining upon the present landscape.

Before mining, the northern and western margins of the Oklahoma coal province had a mantle of prairie grasses and interdigitated

forest. The southern and eastern margins of the coal field are forested, principally with hardwoods, although pine is locally significant.

After mining, annuals and weedy perennials invade non-carbonaceous spoil as soon as it is exposed. Trees typically succeed these early colonizers, although in some areas trees invade fresh spoil directly. Hydrophytic plants grow at the strip-lake margin.

Little tree planting has been attempted on Oklahoma spoil, but forage crops are frequently planted immediately after mining. Tree planting for economic gain holds out interesting possibilities for the future.

JOHN E. DORNBACH — *Charting for Project Mercury*

Project Mercury, the "Man in Space" project of the National Aeronautics and Space Administration (N.A.S.A.), is designed to place the first American astronaut in orbital flight around the earth. The U.S.A.F. Aeronautical Chart and Information Center has been requested by N.A.S.A. to produce various charts and furnish cartographic services required to support this project. This not only includes a navigational chart for use by the astronaut in the space capsule, but other charts and studies necessary for planning, control, and recovery of all phases of the project.

Some of these products or services are as follows:

Mercury Orbit Chart—A 1 : 52,000,000 scale chart designed for use by the astronaut to determine position over the earth's surface and for determining retro-rocket firing and impact points in the event of automatic system malfunction.

Mercury Simulator Graphic—A 70 mm film strip in full color designed to simulate the appearance of the earth as it will be viewed by the astronaut during the three-orbit mission. This film strip covering a 1,640 N.M. wide orbit path is used in the Orbital Attitude Simulator Trainer.

Mercury Test Charts—These charts are to be used for manned and unmanned pre-orbital test flights from Cape Canaveral in which Redstone and Atlas rockets launch the Mercury capsule into ballistic trajectory profiles.

Mercury Recovery Charts — This series of ten 1 : 5,000,000 scale Mercator charts will be used by air, land, and sea forces responsible for a contingency recovery of the capsule and its contents in the event of a landing outside the planned areas.

Special Studies—An example of other special services provided are the terrain and natural vegetation studies made for areas 250 miles on either side of the three-orbit mission. These studies are based on physiography, rock composition, and type of vegetative cover.

As man extends his sphere of influence into cislunar, lunar, and interplanetary space, a need for new and more unique cartographic products is certain to materialize. If the cartographer is to extend his chart-making skills into these areas, he must acquire a new terminology. A few problems already inherent in preparing for man's first trip to the moon emphasize this point.

DONALD R. DYER—*Population and Elevation in Peru*

A striking feature of the human geography of Peru is the great range of population distribution by elevation, especially the number of settlements at very high elevations. Using the criterion of assigning the population of each province to the altitude of the capital of such province, more than one-half of Peru's population lives at elevations higher than 7,500 feet; the median point is 8,600 feet above sea level. Employing the classical division of Peru into three grand regions, and including an estimate of "jungle" inhabitants, 29 percent lived in the coastal region, 61 percent in the sierra, and 10 percent in the selva in 1958.

Since 1876, the relative importance of the sierra has declined from 71 percent to 61 percent of the nation's population, though the sierra increased from 1,907,000 inhabitants in 1876, to 5,444,000 in 1958. Many "highlanders" have migrated chiefly to Lima and other cities of the coastal valleys and some into the montaña, or upper selva. Lines of penetration into the selva have reached below 3,500 feet elevation at seven places into eastern valleys of the Andes.

On the basis of recent changes in distribution of population according to elevation,

speculation on future distribution indicates that the proportion of Peru's population living in the coastal region will increase to approximately 33 percent (4,500,000) by 1975, the percentage living in the sierra will decline to 58 percent (about 8,000,000), and the proportion in the selva will remain at approximately 10 percent.

GORDON J. FIELDING—*Dairy Cities in Southern California: Dairying in Cities Designed to Keep People Out*

Situated in the southeastern portion of Los Angeles County and the adjacent areas of Orange County are three incorporated dairy cities: Dairy Valley, Dairyland, and Cypress. This area of 18 square miles is occupied by 75,000 dairy cows and 6,000 people, and is almost completely surrounded by residential and industrial areas. Agriculture persists as a politically protected enclave.

Dairymen agreed to incorporate in order to escape complaints leveled at dairies by residential owners, and to evade land taxes assessed on agricultural land which had potential for subdivision. Within these cities dairymen can now dictate their own zoning ordinances. Politically, incorporation removed these areas from county jurisdiction. Local councils decide what municipal services will be provided, and sale of land for industry cannot be forced upon dairymen.

Dairying within these enclaves is intensive. The typical 15-acre farm carries 20 cows to the acre. One-third of the farm is devoted to dry-lot corrals, one-third to irrigated pasture, and the remaining third to buildings, structures, and walkways. Cows in milk are restricted to the dry-lot corrals.

Factory-like methods are used to produce milk. Raw material in the form of hay and concentrate feed are imported. Cows convert the raw material into milk and manure, and both the product and the by-product are sold. Dairymen have become specialized feeders and milkers rather than farmers.

Excluding condemnation by state agencies, these cities should persist as dairying areas for at least another decade.

ARTHUR GETIS — *Potential Accessibility and the Location of Retail Establishments*

Various measures of retail potential at urban sites have been developed. However, a major deficiency of these measures for practical purposes is the fact that they do not take into account that the pattern of retail store locations may be influenced by an intervening opportunity between the home base and the retail sites. Potential and intervening opportunity have been considered separately in the well-known gravity models, but a marriage of these two concepts would add greatly to an understanding and prediction of retail site selection in urban areas.

A mathematical model is presented which develops a potential accessibility index for urban sites where the desire to evaluate sites for the location of retail establishments is the main concern. The model is based upon the reasoning that: (1) for any given site in an urban area there is potential demand for retail goods that could be supplied at that site; and (2) intervening opportunities between the consumer and the site in question detract from the potential at that site.

The model is applied to a small, hypothetical community using data from a portion of an actual city. The difficulty of testing the model becomes evident when such constraints as rent, planning restrictions, and various types of economic competition are considered. Research is continuing toward a refinement and objective evaluation of the model. However, the model can be used in its present form as a preliminary device for choosing potentially good sites for the location of retail establishments.

PETER R. GOULD—*A Factor Analysis of Economic Health in New York State*

The question of identifying economically healthy and depressed areas is becoming increasingly important as Federal and State funds are allocated to alleviate the continuing problem of hard-core unemployment and chronically depressed areas.

Currently used, single measures of economic health, such as unemployment, are not only often inadequate but tend to be politically biased. Multiple measures are therefore used in an attempt to obtain a clearer and more objective view of economic health. The use of multiple measures, however, raises the problem of the way in which they are to be combined — a problem usually solved out of expediency by weighting all the measures

equally. In such a situation, Factor Analysis can help the geographer to probe into the problem of identifying economically healthy and depressed areas by condensing a number of measures to a few factors. The Factor Analysis of the New York State data at the county level extracted two significant factors indicating that counties vary in two distinctly independent ways. The maps of county values on both factors provide an objective picture of the spatial variation of economic health in New York State with a logical, rather than expedient, foundation.

PHYLLIS R. GRIESS—*Pennsylvania's Anthracite Waste Lands as a Potential Tourist Attraction*

The economically depressed anthracite region of eastern Pennsylvania for many years has been attempting to attract new industries in an effort to combat chronic unemployment. Failure to achieve satisfactory results can be attributed in significant part to the unattractiveness of the mining areas as sites for plants and homes of workers. The appearance of these areas cannot be altered in significant degree without the expenditure of exorbitant sums of money; nor can such areas be avoided because of the surrounding mountainous terrain. Alternative prospects for growth in agriculture, mining, and lumbering are unpromising; but initiation of a major tourist industry appears to be feasible, since the very factor—appearance—that makes it difficult to draw in new industries and outside workers renders the region of great interest to the visitor.

Tourist assets of the region are associated with its mining landscape. This is characterized by distinctive qualities, both of a general and a specific nature, that would have considerable tourist value if properly exploited. Development of such potential tourist attractions will require major efforts in the fields of advertising and promotion, road improvement, construction of tourist service facilities, and proper display of tourist attractions. Money so spent would probably result in greater additional employment than if it were utilized in an attempt to expand the industrial base of the anthracite region.

JOHN FRASER HART — *Some Components of Population Distribution in the Middle West in 1950*

This is a progress report on an attempt at quantitative description of the distribution of population in a block of nine states in the Middle West, based on 1950 data.

Variations in population density in this area apparently result from the superimposition of two different patterns of distribution. One pattern, which has considerable regional uniformity, is essentially the distribution of the farm population, whose variations are predominantly the result of variations in farm size and in the size of farm families.

Superimposed upon this pattern of regional uniformity is a point-oriented pattern, which is essentially the distribution of the urban and the rural nonfarm population. The pattern of distribution of the point-oriented population is likened to the distribution of scattered sand piles of varying size; the density and extent of the population around each city are crudely proportional to the size of the city's population, just as the diameter of the sand pile is proportional to its height. It is suggested that understanding of variations in the distribution of the point-oriented population will be based upon better knowledge of the rank-size hierarchy of urban centers.

EDMUND E. HEGEN—*Highways to El Dorado: A Report on Six Andean Roads Into the Upper Amazon Basin*

This report deals with six of several roads leading into the tropical lowlands east of the Andes. Fieldwork was undertaken during several months of 1960 along these roads.

In southern Colombia, the Neiva–Florencia Highway and the road from Pasto to Pto. Asis reach the tierra caliente and penetrate into the selva. Both roads facilitated spontaneous migration, and agricultural settlement is permanently established.

In Ecuador only one road reaches the oriente. It leads from Ambato to Banos, Mera, and Puyo. From these it turns northward and will after completion reach the Rio Napo. This road has the same effect as the Colombian roads of penetration: each completed mile draws new settlers, and forest is transformed into permanently cultivated land. The

Cuenca–Paute–Mendez road is only half completed. The road still ends high in the sierra.

In northern Peru two roads cross the Andes and reach the montaña. The Olmos-Maranón Highway crosses the lowest pass of the Western Cordillera, beyond which it follows the courses of the Rio Chamaya and Rio Maranón. It is planned to build the road at least to the navigable waters of the Maranón, below the Pongo de Manseriche. The Pacasmayo – Cajamarca – Chachapoyas road is a trans-andean highway which will connect costa, sierra, and montaña along an important axis. At present, only 54 miles of a total of 350 miles are not completed.

CALVIN J. HEUSSER AND MELVIN G. MARCUS—*Short-term Fluctuations of Lemon Creek Glacier, Alaska, and Their Relationship to the Meteorological Record: 1953–1958*

An effort has been made to consolidate and interpret data collected on Lemon Creek Glacier, Alaska, during a five-year study program sponsored by the American Geographical Society with the support of the Office of Naval Research. This paper deals with one aspect of that summary: the analysis of short-term changes in the hydrological budget of the glacier and fluctuations in the meteorological record.

The budget of the glacier was determined for five budget years from October, 1953 to October, 1958. Although a positive regime was recorded in 1954–1955, a net water deficit of 10,320,000 cubic meters occurred during the full period. This follows a general shrinkage pattern initiated in 1929. Previously, the glacier was at or near equilibrium for a 27-year period.

Annual negative or positive departures from equilibrium are compared to meteorological data recorded at the Juneau Airport, 11 kilometers west of the glacier. These are adjusted to allow for the difference in elevation of the two locations. The relationships involve a complex interplay taking place between the amounts of accumulation, the duration of the ablation season, and the excess temperature above freezing for the ablation months. For the five budget years, it is not possible to interpret trends for any of these individual factors; however, it can be shown how their interaction has resulted in a predominance of negative budgets and over-all wastage of the glacier.

JOHN J. HIDORE—*Variations in Mean Runoff, Runoff – Precipitation Ratios, and Runoff Variability in Iowa*

The runoff from sixteen drainage basins in Iowa and southern Minnesota is compared to determine if systematic differences exist from one drainage basin to the next. The aspects selected for comparison are mean runoff, the ratio of runoff to precipitation, and the variability of the runoff. These aspects of the runoff are examined on an annual and seasonal basis. In most cases a systematic spatial distribution occurs.

LEVERETT P. HOAG—*Causal Factors for Cash-grain Farming Areas in the Corn Belt: A Study of Intellectual Laxity*

The most frequently noted cause for the location of cash-grain areas in the corn belt is proximity to markets. This is almost the sole cause found in geography textbooks. Other sources do somewhat better. The lack of association between cash-grain areas and markets, the apparent lack of sufficient scholarship in certain textbooks, and the simple fact that these cash-grain areas do exist have caused further study of the reasons for the existence of these areas.

The many factors usually given for the location of these cash-grain areas either show no real association with the areas or they likely are results of the system rather than causes of the system. The obvious association is between cash-grain areas and flat land. Field work conducted in and around the major cash-grain areas of the corn belt strongly indicated that the basic reason for this association is the absence of a serious erosion problem when planted to cash grains continuously. While this cause has previously been suggested rather vaguely, no reference could be found which seemed to consider it the basic factor. The hypothesis is presented here, however, that the absence of a serious erosion problem on flat land is the basic factor that permits cash-grain farming to be a logical choice of the farm operators in those areas.

JOHN HOPKINS—*Statistical Evaluation of Relief Data Portrayed on the Aeronautical Chart*

Users of the modern aeronautical chart require not only adequately portrayed relief data, but also a symbolized evaluation of their accuracy. Symbolization of point locators is varied to show the evaluation of spot elevation accuracy. Contours are portrayed as accurate or approximate in accordance with the National Standards for Map Accuracy. Maximum elevation values reflecting the accuracy of both spot elevations and contours are positioned in each one-degree quadrangle to inform the user of the highest expected terrain he may encounter.

Since it is impractical to accomplish a point to point, line to line, comparison of source maps with geodetic information, or perform actual field checks, which are time-consuming and costly processes or impossible in much of the world, a statistical technique of evaluation is being developed. Random samples of source maps to be used in a compilation are compared with correlated geodetic information to estimate parameters of the Normal Distribution and establish confidence limits for the amount of error in contours and spot elevations.

These techniques have been found to be advantageous over other alternatives, especially in savings of manhours and calendar time.

TOSHIO HOSHIDE—*The New National Land Base Maps of Japan*

Plans have been laid for a ten-year program for the preparation of some 55,000 sheets of the New National Land Base Maps of Japan. Urban and flat areas will be at 1:2,500 scale with the hill and mountain areas at 1:5,000 scale. This paper deals briefly with some aspects of the program which should be of interest to geographers.

JAMES M. HUNTER—*The Extent of the Legal Confines, the State Idea, and the Zone of Function of France and Germany in the Saarland*

The extent of the territory of states has long been treated as a fixed fact. In contrast is a Ratzelian concept in which the irregularities and changing conditions in the extent of the territory are held in primary importance. This paper will demonstrate the latter.

The territory of the Saarland is examined at various points of time for the purpose of classifying its legal status, the type of state idea in existence, and which state, France or Germany, actually controlled the performance of its internal functions. It is noted in each case whether the final status resolved itself to be a centrifugal or a centripetal force on the internal functions of the state holding legal possession.

The similarity of non-viable functions producing the changing political functions is exemplified in treaties at the conclusion of the First and Second World Wars. But the period in which the greatest number of irregularities occurred is after agents, performing political functions for the two major states involved, agree to hold a plebiscite for the purpose of determining the future political status of the Saarland. This period of almost three years finds the external economic functions of France appearing in the tenth state of the Federal German Republic and holding priority over the Bonn Constitution.

It is suggested that other studies of this nature could be made concerning the functions of the United States and Soviet Russia beyond their legal confines on the territory of Japan and Austria respectively after the Second World War.

J. GRANVILLE JENSEN—*Observations on Agrarian Land Reform in Mexico in the 1960's*

The political regime of President Adolfo Lopez Mateos is giving new emphasis and new concepts to the half-century-old agrarian land reform of Mexico. Graphs and maps show trends in land donations and distribution in the nation to 1961, for *ejidos*, new centers of population, and colonies. Based on the evidence of these data five points are noted as characterizing recent development: (1) vigorous dedication of the political to agrarian reform, (2) intensified implementation leading to two major forms of land tenure—the *ejido* and the small private ownership, (3) increased efforts to create a feeling of security of ownership among rural families, (4) increased efforts to translocate groups of families from populous areas to lowlands of the west and south, and (5) increasing aid under an

expanded concept of the obligation of government to the rural family.

FERENCZ P. KALLAY—*The Oristanese Project: An Effective Attack Upon an Old Problem*

For centuries the economy of southern Italy, Sicily, and Sardinia has remained almost stagnant. Even economic recovery measures which greatly aided the industrialized northern section of Italy did little for these areas, and it was not until recent years that the Italian government has been able to show any real progress in raising the economic standards of the traditionally depressed South. The so-called "Fund for the South" (*Cassa per il Mezzogiorno*) has been active throughout the region, and it is the purpose of this paper to illustrate the effectiveness of this agency in one particular area—the Oristanese of Sardinia. It should be remembered that the Oristanese is, in many ways, not unique. Rather, it is an example of the dramatic social and economic change initiated by various agencies of the "Fund for the South" throughout southern Italy and the Islands during the past decade. The policy of government-financed colonization of depressed areas, of large-scale irrigation projects, and of community planning and construction may well be the impetus necessary to raise the economy of the Oristanese—as well as the rest of this depressed region—to a level comparable with that of the rest of Europe.

HERBERT G. KARIEL—*Some Aspects of the Spatial Distribution of Population Change in the West North-Central States*

Spatial distributions of population, population composition, and population growth or decline are related largely to areal differences in employment opportunities, types of economic activities, and other social and economic factors. In general, problems in population geography might be defined as attempts to account for spatial distributions of these phenomena and, if they have not been isolated, to identify the relevant factors which would account for them. The present paper focuses attention on two things. One of these is the relation between population change and selected variables. The other is an approach to the consideration of population change which will help to identify the relevant variables.

Using a sample of 100 counties in the West North-Central States, multiple regression analysis is used to determine the degree of areal association between population change and selected social and economic factors. A map of residuals from regression is used to indicate areas in which there is little correspondence between the observed and the actual values. Because of the resultant findings, the sample is split into two groups: 34 areas of population growth and 66 areas of population decline. Further application of regression analysis is repeated for each of the two subgroups.

The findings suggest that two conclusions can be drawn. First, it is advisable to concentrate on either population decline or population growth in making a study of population change. It is likely that different relevant factors are operating in areas of population growth than in areas of population decline. Secondly, some of the variables operating in each of the types of areas which are significant in accounting for a large proportion of the variation of population growth and decline have been identified.

ARTHUR E. KARINEN AND DAVID W. LANTIS—*The Population of California: 1950–1961*

Since 1940 California's population has increased from six to 16 millions; by 1963 the state could become the most populous.

Increase displays uneven distribution, occurring largely in Southern California and the Bay Area. Since 1950 Los Angeles County has gained as many inhabitants as resided in Los Angeles a decade ago: contiguous Orange County added 500,000. Climate and economic opportunity encourage younger families to settle around Los Angeles while farmers must relocate elsewhere. San Diego grows rapidly despite somewhat limited opportunity.

The Colorado Desert gained little during the 1950's, although Coachella Valley agriculture expanded and population doubled around Palm Springs. Significant growth occurred in the Mojave which functions as a gateway corridor and winter vacationland. The Great Basin declined despite Death Valley visitors. The Northeast lost a third of its people; ranches have become larger and military activity and lumbering declined. The Southern Cascades gained with additional lumbering, expanded commerce and recreation. The Sierra Nevada

showed modest increase. Distinctive growth occurred in those foothill towns with residence appeal.

San Francisco lost 30,000, although the Central Coast experienced much growth, particularly on the Bay Area periphery. Fast-growing San Jose and Fremont should become large cities. The Northwest grew slowly except on fringes of the Bay Area.

With the exception of several cities, the Central Valley gained modestly. Industrial growth has been limited. Expanded San Joaquin irrigation kept California from declining in cultivated acreage. One wonders if this is to become "America's China"?

YING-CHENG KIANG—*A New Method of Classifying Cities*

The classifications of cities according to their economic functions at least serves two purposes: (1) to identify the leading industries, and (2) to compare cities in different stages and areas in terms of their major functions. Several methods of classifying cities have been used by geographers, but they are inadequate. The new method of classification is based on the majority and leading roles. Cities classified as manufacturing or retail should have at least 50 percent of their workers engaged in manufacturing or retailing, respectively. Otherwise, they should be classified as diversified and divided into many types according to their leading activities. The relative importance of the leading activities can be indicated by numbers.

The application of the new method is made for 510 random samples of American cities. Sixty are manufacturing towns. Two are professional (college or hospital) centers. The 448 diversified cities are divided into seven types: manufacturing (316), retail (92), professional (20), government—capitals or military bases (8), transportation (7), personal service (4), and mining (1). The personal service or retail type includes regional centers (Salt Lake City, Utah), resorts (Miami, Florida), or residential suburbs (Pasadena, California). If more samples are examined, more city-types may be found, such as Sanford, Florida, a diversified city of agricultural type, or Boulder City, Nevada, a diversified town of construction type. Also, the method calls for more comprehensive census data, especially regarding commuting, for a more realistic identification and comparison of cities.

EUGENE C. KIRCHHERR AND WILLIAM A. RIPATTE—*The Burdick Mall of Kalamazoo: A Study in CBD Redevelopment*

During 1955 and 1956, a decline of the Central Business District of Kalamazoo, Michigan was becoming apparent. This prompted a group of businessmen to contract an outside organization to undertake a comprehensive study of the CBD. The report was submitted in 1958, and outlined a program of CBD redevelopment by stages through 1980. As part of the first stage, it was recommended that Burdick Street, a major shopping street, be closed to traffic and converted to a pedestrian mall. The implementation of this plan in Kalamazoo resulted in what is now considered the first permanent pedestrian mall in the nation.

The Burdick Mall, completed in 1959 with an extension added in 1960, now extends approximately one-quarter mile through the heart of Kalamazoo's CBD. Yet this project has not been without problems, for the transformation of a shopping street into a pedestrian mall involved legal questions and methods of financing. It has necessitated changes in previous patterns of circulation and created needs for additional parking space. However, these matters have been resolved, and although attempts to generalize about the success of the Mall would be premature, there are tangible effects which have been generally favorable.

The Mall is a product of positive and cooperative action by city officials and local businessmen mutually concerned about the problems of a declining business district. Nevertheless, the Mall is not regarded as an end in itself, but only one aspect of a broader plan of CBD and community planning.

MANUELA G. KOGUTOWICZ—*The Importance of National Atlases*

In 1956, the XVIIIth International Geographical Congress in Rio de Janeiro created the Commission on National Atlases.

Professor K. A. Salishchev, the head of the cartography department in Moscow State University, became the chairman of the commission. The members of the commission are

reputable scientists in geography and cartography from different countries. They undertook to work out the best sample, the one most technically and cartographically correct base for geographic research of the world, which could also be a useful source for the World's International Map Series.

Reviewing the historical background of the national atlases, we find good samples, done by different smaller countries. The big countries, such as Australia, Canada, the United States, and the Soviet Union, have more problems due to their larger territorial expanse. The National Atlas of the United States needs more publishing agencies in order to speed up their successful work.

The XIXth International Geographical Congress in Stockholm appreciated many of the above-mentioned suggestions and has shown an increasing interest in international cooperation in national atlases.

JANE LANCASTER—*A Railroad To Great Slave Lake*

The Canadian government has been proposing the construction of a railroad to Great Slave Lake for the past five years. An all-season highway connects the lake with Alberta, but trucking rates are prohibitive to moving out base metals or concentrates from the District of Mackenzie. Barge rates are low, but waters are ice-free and navigable only three months of the year. Air transportation is convenient but expensive. The high unit values of gold and uranium have compensated for the high cost of air transportation south to rail lines; base metals, however, could not be feasibly shipped out by air.

The economy of the Great Slave Lake region is based largely upon mineral extraction. There are many base metal deposits, some of them partially developed, waiting for a railhead on the lake. Notable among these is the Pine Point property, containing the largest ore reserves of lead and zinc in North America.

A railroad to Great Slave Lake would reduce freight rates, increase the traffic-handling capacity of the Waterways-Great Slave Lake route, and permit all-year movement to and from the lake. The need for the rail line has been agreed upon, but not the route. One faction proposes a line north from Grimshaw to Hay River (paralleling the Mackenzie Highway); the other faction wants a line north from Waterways to Pine Point. The Dominion government has been hard-pressed to make a conclusive selection.

In the meantime, the base metal deposits are lying dormant, awaiting improved transportation facilities to Great Slave Lake.

RICHARD E. LONSDALE—*Industrial Location Planning in the Soviet Union*

There are two fundamental steps in Soviet industrial location planning. First, planners turn to a body of general socialist planning principles and make broad recommendations regarding the general course of development. Second, planners proceed according to specific locational policies to determine particular places where production costs are lowest. Locational decisions are incorporated into national or regional economic plans.

General socialist planning principles, which guide or justify broad locational decisions, have their roots in the economic teachings of Marxism-Leninism, and represent the antithesis to "irrational" industrial location under capitalism. The most important of these principles are (1) reduce freight hauls by establishing industry closer to raw materials and markets, (2) secure the broad industrial development of all regions of the U.S.S.R., (3) promote specialized production in regions possessing uniquely favorable conditions, and (4) develop industry in backward areas to raise their economic and cultural levels.

Specific locational policies are largely consistent with Western principles of substitution and comparative advantage. The Soviets make extensive use of cost accounting as the only practical way of determining those locations where production costs are lowest. Cost calculations consider such factors as proximity to raw materials and markets, transport rates, and labor availability. On the subject of location theory the Soviets have little to say except to denounce Western theories.

In a hypothetical situation where conditions are identical, Soviet and Western planners might well arrive at similar conclusions, but the line of reasoning in each case would likely be quite different.

DAVID LOWENTHAL AND LAMBOROS COMITAS—*Emigration and Depopulation: Some Neglected Aspects of Population Geography*

Considered in terms of the movement of people, there are three different kinds of places in the world: those that people stay in, those they move to, and those they leave behind them. The first two types are familiar to almost everyone; we live in them. But about the places that people leave? Although the "Town That Has Gone Downhill," vividly described by Goldthwait a generation ago, is the prototype of countless communities, the effects of emigration and depopulation in general are little known.

The phenomenon of population decline is widespread in communities throughout the world; owing to migration, instances of local and regional decline naturally accompany a general increase in population. Varieties of emigration are surveyed in terms of the spatial and social range, the historical epoch, the duration, and the intensity of the population shifts involved. Case studies of Montserrat, West Indies, and of Ithaca, Greece, are used to illustrate the impact of emigration and depopulation on the social, economical, and political life and ideological commitments of those who remain behind, the relationships between emigrants and their homelands, and the final fate of such decimated and diminished communities in the modern world.

M. E. MARTS—*Basin Development Approaches and Geographic Diversity in the Columbia River Basin*

The diversity of the physical, economic, and political geography of the Pacific Northwest results in a wide variety of development and management problems in the case of the Columbia River program. The problems stemming from this diversity have been especially difficult in the long efforts to arrive at acceptable solutions of the upstream-downstream conflict.

The efforts to develop a solution of the upstream-downstream conflict have been primarily focused on achieving a mutually acceptable institutional arrangement, or mechanism, for representing all interests and resolving conflicts of interest. The arrangements which have been considered, sought, and/or established have been (1) the established federal agency approach, (2) the valley authority, (3) the interstate compact, and (4) the international treaty. Each of these approaches has been affected in various ways by the geographic diversity of the region.

This paper will explore the relationships between the various approaches and the conflicts of interest stemming from geographic diversity. The current situation is highly confused, and prediction is hazardous, but certain observations can be made as to the relative compatibility of the various approaches with each other and with the geography of the region. Among these observations, it is interesting to note that important progress has been made under the established federal agencies and toward an operable international arrangement, and that the least progress has been made in establishing a valley authority or concluding an interstate compact. In several important respects, the establishment of an international treaty has been easier than establishing an interstate compact (or "treaty"), reflecting contrasts between the geography of British Columbia and the United States portion of the Columbia River Basin.

NEIL M. MCARTHUR—*Lakeland, A Setting For Grass Roots Urban Rehabilitation*

Lakeland is a colored neighborhood of 550 persons located in College Park, Maryland. Housing is well below the standard that prevails elsewhere in the city and some 20 percent is so dilapidated that the present structures cannot be rehabilitated. One proposal that has been put forth for the renewal of Lakeland is a full-fledged public housing program. The author feels that this is undesirable because it encourages a transient population to settle here and destroy the present strong neighborhood identification. As an alternative a grass roots program of rehabilitation is suggested with resident participation, a housing committee of residents and city officials, and a publicity campaign to gain support for the project. A recently completed survey indicates that the present residents can afford much better accommodations than they now have. After voluntary rehabilitation has gone as far as it can go, a housing authority should be established to arrange for limited spot Federal housing of single or duplex units. It is felt that this approach would not upset the

rather delicate status quo of Lakeland within the College Park Community, whereas a sweeping public housing program from the beginning would certainly do so.

MARY MEGEE—*The East St. Louis Industrial Area—The Vacant Land and the Areal Image*

This study is concerned with the East St. Louis industrial area, a region of heavy industrial concentration at the southwestern end of the United States manufacturing belt. Two aspects are considered: (1) an analysis of the vacant land which resulted from mapping vacant tracts and classifying them for industrial suitability; and (2) a characterization of whole communities as locations for industrial concentration. A knowledge of the area led to the assumption that there was a large amount of open land available for industrial development in the East St. Louis area, but that the physical appearances of the communities in the area were repelling industry. The East St. Louis industrial area was delimited, and the hypothesis was tested by an analysis of over 40,000 acres of vacant land in a 200 square mile area. It may be concluded that the East St. Louis industrial area is well-suited for immediate and future industrial development in terms of availability of large tracts of level, flood-free land and accessibility to an excellent transportation complex. Moreover, the area has access to a considerable market, other industries, water, and industrial raw materials—all located within a 100-mile radius. The areal image, however, is a deterring factor to industrial location, but it is expected that in the long run the physical and economic advantages of the area may probably outweigh the more temporal cultural disadvantages.

ALFRED H. MEYER—*Areal Man in Demographic Perspective*

The so-called "Population Explosion" problem of the 20th century is viewed by many scientists and statesman alike as of present-day pre-eminent significance. The acceleration rate of increase of world population preoccupies attention of the press and of the pulpit, of science and of government, and of virtually all areas of the academic disciplines. At the same time, "population pressure" is one of the most controversial issues, partly because of varied ideological viewpoints and partly because of inadequate population distribution data and means of measuring the significance of the various population patterns.

The geographer is challenged to seek a systematic world survey of natural and human resources from which reports and maps can be made of the "geographic relationship" type. We need better to understand "geographic man," before we can intelligently talk about the world or regional population, "population pressure," "population explosion," and their significance in our world society and economy. The International Geographical Union would seem to be the best equipped to project the global one-scale inventory mapping task. With the assistance of the various national geographic societies, it might arrange for some uniform procedure and formulae for composing the indispensable "ratio" maps revealing regional differentiations in present man-land productivity and future potential capability. Such findings, then, could very well be used by such an agency as the Economic and Social Council of the United Nations, working in conjunction with the International Geographical Union, in effectuating policies which will equate world potential food production and diffusion with world population potential.

RICHARD L. MORRILL—*Local Migration and Urbanization in Sweden*

Geographers are interested in understanding the development of patterns of settlement and transportation. Although progress has been made in this endeavor, we may recognize some inadequacies: the failure to include the historical dimension, activities such as manufacturing, and the random effect of the inability of persons to make perfect decisions and of our ability to treat all the forces affecting a situation. The historical dimension must be included, since growth of settlement patterns is a process in time, and this greatly distorts a purely spatial theory.

A model is presented of the simulation type, that is one which seeks to produce patterns very much like real ones, but cannot hope to reproduce them exactly. Various forces tend to determine locations of places or destination of migrants, but there is always an element of choice, which must be settled by random methods. The model provides methods for

locating central places, manufacturers and railways, and for predicting migration.

The model is applied to an area in southern Sweden. The actual development is traced in detail, and the model is used to simulate similar patterns of migration and urban development. Several maps are presented to compare the actual and simulated changes over a hundred-year period. The degree of success is such as to recommend the method to a wide range of problems of location and movement, in which time and space are interwoven.

A. PHILIP MUNTZ—*Union Mapping Activities in the Civil War*

Interest in the Civil War has been greatly stimulated by the Centennial now in progress, and large quantities of material relating to the War are being published, but information concerning maps and mapping activities of the period is almost unobtainable. Such problems as the significance of maps in the operations of the War, the organization and techniques of military surveying, mapping, and map reproduction, and even the seemingly elementary questions of the kind and quantity of maps produced, have importance not only for military historians but also for historical geographers and particularly for students of historical cartography.

Although it was almost immediately apparent at the beginning of the War that detailed topographical maps were essential in planning and implementing successful military operations, useful maps were then extremely scarce. In meeting this situation, the North had a distinct advantage over the South in that the organization, files, equipment, and most of the personnel of the two agencies of the Federal Government responsible for topographical mapping remained with the Union. These agencies, the Corps of Topographical Engineers and the Coast Survey, produced thousands of maps which contributed significantly to the Union victory and which today are an invaluable record of military operations, the landscapes of the period, and the cartographic techniques that were employed in their production. Many of these have been preserved, and several thousand are now in the custody of the National Archives. The illustrations that accompany this paper are copies of such maps, chosen to represent specific types of maps or significant innovations in map preparation or reproduction.

MALCOLM A. MURRAY—*The Geography of Death in England and Wales*

This paper portrays the pattern of death rates in England and Wales with respect to total deaths and selected categories of causes-of-death. With some exceptions total death rates tend to be distinctly higher in the industrialized, exploitive, and densely populated areas such as the Lancashire and Yorkshore manufacturing area, the Birmingham and Black Country district, southern Wales, Durham, and Tyneside, as well as more isolated examples such as Stoke-on-Trent. The London area ranges around the average. The more prosperous agricultural counties of the south and east generally experience lower rates than the low grade farming and grazing counties of the north and west. On the broad basis, northern England, the Pennines, and Wales experience higher rates than southern England. The association between death rate variations and other distributions, both cultural and physical, is readily apparent to those familiar with the geography of Great Britain.

These associations also pertain for most major categories of causes-of-death. Exceptions to this generalization are found within the category of cardiovascular disease.

The cause-of-death categories mapped include bronchitis, pneumonia, tuberculosis of the respiratory system, malignant neoplasms of the trachea, lungs, and bronchus, malignant neoplasms of the stomach, vascular lesions affecting the central nervous system, arteriosclerotic heart disease, and infant mortality.

G. ETZEL PEARCY—*Air Route Patterns*

On the average about 2,000 commercial airliners are flying the world's airways at any one time. Another 3,500 are sitting on runways or in overhaul shops. Scheduled flights send these aircraft over an extensive air route pattern reaching virtually every habitable part of the globe. In the United States planes carry more inter-city passengers than do either railroads or bus lines, and over the oceans more than do ships. The present global route system reflects forty years of development, starting with flights which were little more than barnstorming ventures. Although the routes

created have been based primarily on traffic potential, political and technical factors have influenced their structure.

At the outbreak of World War II each of the continents had its own network, but long distance trans-ocean route segments were in their infancy. The war with its requirements of rapid advancement in aeronautical science gave tremendous impetus to postwar commercial flying. Then it was that routes spanned the oceans to inter-connect continents. Regional service to smaller communities developed along with that of trunk lines.

Non-stop flights represent the last major stride in route pattern evolution, introduced by piston planes and inherited by jets. Transcontinental and trans-ocean flying at close to 600 miles per hour now highlight the world's routes. Next must come attention to the short-haul—how to carry the millions of potential passengers between neighboring communities without the undue loss of time now suffered by increasing surface traffic and inadequate short-distance aircraft.

ALLEN K. PHILBRICK—*The Dispersed City in Michigan*

A unit-area land-use map of a 47-county region of Michigan's lower peninsula was made. The paper reports the discovery of a new dispersed form of urban settlement which is defined as the *dispersed city*. The land-use map shows the distribution of this settlement form.

The map is analyzed in terms of two other maps derived from the original land-use survey. The first of the two interpretive maps defines a composite web of highway impact associated with the dispersal of urban-type land uses from the cities of the study area. The second interpretive map defines Michigan's dispersed-city realm.

The significance of the newly defined form of dispersed urban settlement lies in the fact that it probably predicts the future shape of more densely concentrated urban development if present trends of dispersion along and through the agency of highways continue.

ROBERT D. PICKER—*Market Characteristics and the Growth of Production in the Kuznetsk Coal Basin of the Soviet Union*

Although the Soviet Seven-Year Plan stresses an increased consumption of petroleum and natural gas, and the percentage of coal within the Soviet energy balance has been reduced, coal will still represent 43 percent of Soviet energy consumption by 1965. Major supplies of high quality coal for industrial use in the U. S. S. R. are deposited in Siberia far from major industrial centers. In this respect the key deposit is the Kuznetsk Coal Basin. Its tremendous reserves have been examined; but, a functional analysis of Kuznetsk production and its market area has been neglected. Thus information regarding Kuznetsk operations within the framework of Soviet industrial growth has been lacking.

The Kuznetsk Coal Basin furnishes much of the energy demanded by the Soviet economy. Future plans indicate the basin will remain a supplier of metallurgical and power industries. Production is shipped to almost all sections of the Soviet Union, the market area extending almost 3,000 kilometers to the west of the basin.

Kuznetsk output has grown steadily, and today the basin is the second largest coal producing region in the U. S. S. R. Although the rate of growth in the postwar period was not as great as prewar, in 1959 the basin contributed two-fifths of Soviet increments. The decline of older mining areas in the basin and a shift to lower quality coal for coking has not diminished the significance of the Kuznetsk Basin. In fact, its deposits are a principal determinant of an eastern extension of the Soviet economy beyond the Urals and remain a foundation of industrial growth in the U. S. S. R.

OTTO W. PONGRACE—*Geo-Economics of Railroad Industrial Development*

As our Country developed, the need for transportation grew. The Industrial Revolution and the growth of the railroad industry were concurrent and correlated.

Cities and towns grew along railroad lines and with them came the factories. Need for increased production forced expansion of these plants while society demanded better living and working conditions.

The changes our society experienced after World War II led to further decentralization as well as expansion of industry. Industries faced decisions they never had before. An industry seeking a new plant site now shapes its

future by applying reason and research. These techniques require the services of professional specialists. Thus, the role of the industrial developer came into being.

Railroads provide industrial development services to prospective shippers by utilizing the many and varied talents already employed in the Marketing, Engineering, Research, Finance, and Real Estate Departments to provide for complete market study and site analysis. Design construction and financing of a new industrial plant can also be arranged.

Railroads work with various agencies to achieve the best use of land, water, and other natural resources through zoning, community planning, and area development.

The efforts of these professionals, whether developer, engineer, or geologist, are reflected in increased freight revenues from industries located where they make optimum use of natural and economic resources.

LEWIS T. REINWALD—*A Computer for Geographers*

This paper surveys the implications of large-scale computers to the geographer. It describes a general program system to be programmed for a computer such as RCA 501, the IBM 704, or UNIVAC, and to be utilized to perform many of the routine, time-consuming tasks in geographical research. The system's organization and input language are described; several examples of the system's application are provided.

The final portion of the paper considers the contribution that geographers might make in designing such a system and the return contribution that the system could make to geographers.

WALTER W. RISTOW—*John Melish, Geographer and Map Publisher*

Geography is a relatively youthful profession. Its development and growth in the United States have occurred within the life span of members still active in the Association of American Geographers. Geographical interests and publications, however, may be traced back to the beginning years of the United States.

One of the first practicing geographers was John Melish of Philadelphia. A native of Glasgow, Melish's early career was in textile manufacturing and merchandising. Business and personal interests took him on several extensive journeys through the United States. The journals of these tours, illustrated with eight personally prepared maps, were published by Melish in a two-volume work in 1812.

The success of the travel book, and encouragement from friends, led to the publication of a *Military and Topographical Atlas* in 1813. This was followed by a number of other cartographical and geographical works, prepared and published at Melish's map establishment in Philadelphia.

Among Melish's major contributions are the large map of the United States, first published in 1816, and a map of Pennsylvania, based on official local surveys, which appeared in 1822. For his United States map, Melish introduced the commendable practice of listing all compilation sources in an accompanying "Geographical description" booklet. He is also credited with having been the first to advance the suggestion for a series of state maps at a uniform scale. This plan was subsequently followed by Henry S. Tanner in his monumental *American Atlas*, published in 1823.

H. B. RODGERS—*The Lancashire Cotton Industry 1920–1960: The Geography of Decline and Reconstruction*

This study in the geography of industrial decline traces the progressive decay of the cotton manufacture of Lancashire over a period of 40 years during which it has shrunk to less than one-third of its maximum size. The loss of export markets to Asian rivals, the more recent erosion of the home market by cheap imports from Hong Kong, the technical backwardness of the industry, and its drastic wartime concentration are the chief causes of its difficulties. Contraction has varied regionally within Lancashire, and the purpose of this paper is to analyze the changing distribution of the industry and the effect of its decline on the pattern of intense regional specialization in particular sections of the trade which has been for so long its dominant geographical feature. The period is divided at the year 1951: only a summary of the changes of the earliest decades is attempted, in order to make possible a fuller treatment of the recent con-

centration and reorganization of the industry under Government sponsorship.

A map shows pronounced local contrasts in the rate of contraction over the period to 1951, which marks the crest of the postwar recovery of the manufacture. The north of the region, which has long contained the bulk of the weaving branch, suffered worse than the south, where the more buoyant spinning and finishing branches are located. The coarse-weaving district centered on Blackburn, directly exposed to the full force of Asian competition, lost two-thirds of its mill-employment, while the fine-weaving towns east of Burnley lost only one-third. There were similar but slighter contrasts between the Bolton fine-spinning and Oldham coarse-spinning areas. Remoteness from Manchester, the commercial focus, so affected many of the outlying districts that there was some peripheral contraction of the cotton province.

Accustomed though it is to difficulty, the cotton industry has since 1951 faced a crisis which threatens its extinction. A flood of duty-free Asian imports has poured into Great Britain in such swelling volume that it was clear by 1959 that the industry was no longer able to survive by its own efforts. Hence it gladly accepted a plan for drastic—but compensated—contraction coupled with subsidized modernization, which has secured the scrapping of 49 percent of the spindles and 40 percent of the looms. Significant changes in the geography of the manufacture have occurred and are shown in 4 maps. Again the weaving region of the north has felt the decline most keenly; indeed, the weaving branch is leaving its traditional home and migrating south and west, into areas associated in the past with spinning. Thus the old geographical separation of the two branches is weakening, and they are becoming re-integrated, chiefly in the south and west of the province.

The prospects for the survival of the industry are reviewed, for the changes in its geography have some bearing upon its future. Paradoxically, labor is scarce in this shrinking manufacture, for new industries have absorbed the redundant mill hands. Yet technical modernization depends on the adoption of shift work, which in turn is governed by the labor available. Thus labor supply may be the key to survival. Unfortunately there is some regional disharmony between the distribution of the skilled operatives lost to the industry and the demand for them. Newly redundant labor is most plentiful in the north and parts of southeast Lancashire, while the demand is greatest in the west and in Rossendale. But whatever the ultimate fate of the industry, it can no longer dominate the regional economy.

THEODORE H. SCHMUDDE—*Characteristics of Surface Configuration, Soil Texture, and Natural Drainage on the Middle Mississippi River Floodplain*

Between St. Louis, Missouri and Thebes Gap, the Mississippi River floodplain exhibits soils of sandy texture associated with areas of distinct surface irregularity that prevail along the river and across much of Kaskaskia Island and the floodplain opposite Cape Girardeau, Missouri. Elsewhere, the floodplain exhibits fewer surface irregularities and increasing dominance of soils with silt loam and silty clay textures. Thus, as a rule, the area covered by soils of fine texture increases with increasing distance from the river as well as showing a trend of increasing down-valley on the Mississippi floodplain from the mouth of the Missouri River.

The degree to which drainage is a problem is largely dependent upon the combined effect of surface flatness and the dominance of silty and clayey soil textures. Topographic lows present only minor local problems of drainage. The low gradients of flat surfaces reduce the rate of surface runoff and the soils of fine texture so often associated with these areas retard subsurface drainage into the underlying sands and gravels. Hence, conditions of surface configuration and soil texture are basic factors influencing the increasingly greater area of inadequate natural drainage with increasing distance from the river and in a down-valley direction, with the notable exceptions to the trend at Kaskaskia Island and the floodplain opposite Cape Girardeau.

JOSEPH E. SCHWARTZBERG—*Agricultural Labor in India: A Regional Analysis with Particular Reference to Population Growth*

The 1951 Census of India and the large-scale Agricultural Labour Enquiry of the same year yield rather disparate findings as to the national and regional degrees of dependence

on agricultural labor. The two investigations are compared and critically evaluated and, to the extent possible, the results are reconciled on a regional basis in three broad categories: areas of high, medium, and low dependence.

In discussing the causes of the regional variations brief consideration is given to the dominant crop grown and the local attitude toward the use of female labor. Most of the analysis, however, relates to the consequences of differential patterns of population growth. Among these consequences are: (1) varying degrees of population pressure and subdivision of agricultural landholdings to sizes too small to support the owner's household; and (2) the loosening of customary ties of artisan and serving castes to agricultural households and the attendant necessity of substituting agricultural wage-labor for the traditional services rendered. Differential mortality rates among landless and landed segments of the population in times of famine are also touched upon.

The significance of the question of dependence on agricultural labor in the context of economic and political development is outlined in conclusion.

RICHARD V. SMITH—*The Distribution of Manufacturing and Population Change in Puerto Rico*

The distribution of new manufacturing industries is of basic concern within an underdeveloped country. Controversy revolves about the virtues and drawbacks of concentration versus decentralization. This paper is a further report on the Puerto Rican locational problem first discussed in a paper three years ago at these meetings.

The Puerto Rico Economic Development Administration has been operating under a policy of industrial decentralization since 1953, with the object of providing factory employment for residents of rural areas and outlying towns and reducing the rate of metropolitan growth. The success of the program has been low relative to the overall success in attracting new manufacturing enterprises. Decentralization has been an asset through the slowing of San Juan's growth and providing some new employment elsewhere. However, the distributional pattern for manufacturing is nearly identical to that at the program's start.

Five factors are counted on as major forces in stimulating a broader distribution, including the development company's construction program, controlling rental rates for standard buildings, direct financial payments for location outside presently important industrial areas, highway improvements, and the development of several completely integrated regional centers as principal focal points.

The problem of industrial location is critical due to the overly rapid growth of major urban centers and a marked decrease in population in rural and outlying communities. The direct and indirect effects of industrialization in or near to these latter areas, it is thought, might stabilize the population distribution problem.

THOMAS R. SMITH—*Geographic Change and Location-type Areas in the Blast Furnace Industry of the United States, 1901–1960*

The historical geography of the blast furnace industry is presented within a framework of ten districts, a modification of the six-district arrangement currently used by the American Iron and Steel Institute. Capacity maps are prepared for the years 1901, 1926, 1938, and 1960, and are based on refinements of the listings in the *Directories* for the respective years. On the maps for 1926 and later, the distinction is made between those centers and localities which expanded more rapidly than the national average in the preceding period, and those whose rate of expansion was slower. The clearest areal distinction on this basis appears on the map covering the 1901–26 period. On this map the Ohio River forms a general division between Pittsburgh and eastern centers of below average rates, and centers to the north and west which expanded more rapidly than the national rate of 110 percent increase. This clear-cut distinction is not evident on the maps covering the subsequent periods.

When capacity is plotted on vertical-log paper, several districts are seen to have continuously upward trends, although at varying rates. These "expanding districts" are: Pittsburgh, Lake Erie, Chicago, Eastern Tidewater, and Western. In contrast are the "lagging districts" in which revival from sharp declines between 1926 and 1938 has, in most instances, been sluggish. These are the Youngstown, Southeastern, Eastern Inland, Ohio, and Interior Midwest districts.

From this there emerges the concept of "Lo-

cation-type areas," which are limited in areal extent and which have provided the optimum locational advantages for the industry during the past sixty years. These are designated (1) Tidewater, (2) Lower Lake, and (3) Ohio River, including Pittsburgh. Centers in these location-type areas have accounted for 80 percent of the increase in capacity from 1901–1960, and appear likely to continue their dominance in the foreseeable future.

HOWARD A. STAFFORD JR.—*An Evaluation of Selected Factors Influencing Grocery Store Locations: Des Moines, Iowa, 1958*

This study attempts to assess the nature of the grocery store locational pattern in Des Moines, Iowa, in the year 1958, and to evaluate the effect of certain variables on that pattern. A map of grocery store locations reveals that the stores are not uniformly distributed over the city. The problem, then, is to account for these variations from uniformity by the concomitant variations of other variables which are thought to be associated with the dependent variable.

The investigation indicates that in order to predict the number of grocery stores per statistical area most accurately, three factors should be taken into consideration. These three variables are: (1) population per statistical unit; (2) mean value of dwelling units (as a measure of income); and (3) mean size of grocery store. The significance of these three factors lends substantiation to the notion that grocery retailing is a convenience function which serves the general public.

The fact that little more than one-half the spatial variations in the dependent variable can be explained by variations in the above-mentioned independent variables reveals that a highly precise explanation of the distribution of the dependent variable is a far more complex goal than is ordinarily supposed. The three most promising areas for further research seem to be: (1) the introduction of new independent variables; (2) more accurate measurement of variables; and (3) investigations conducted in urban areas other than Des Moines, and at times other than 1958.

KIRK H. STONE—*Finnish Fringes of Settlement*

The classification of the fringe of settlement region, previously made in Norway and Sweden, has been extended to Finland. This provides understanding of experiences which might be used for planning new settlements in comparable Canadian and Alaskan zones.

Southern Finland is a region of continuous settlement. It appears to be completely occupied so that settlers can get aid quickly from any direction. All-year bulk transport routes are near everyone.

The northern two-thirds of the country, an area of discontinuous settlement, is the fringe region. Distribution and regional and local accessibility of population limit the directions from and increase the time in which a settler may get aid.

The region has four zones. On the south is the inner fringe, with sheetlike and linear population distribution patterns and inter-regional and local railroads and roads. Next northward, the middle fringe, has linear and spotty population distribution served by two local railroads and fewer inter-regional and local roads than the inner fringe. Farther north is the outer fringe zone with spotty population, two inter-regional roads and some local roads which do not reach all settlers. Farthest north are four areas of outermost fringe, extending into Norway and the Soviet Union, where a widely scattered spotty population has no roads or railroads.

Results of the classification are encouraging. Zonal lines throughout Norden are conformable and similar zones are present in northern North America. In spite of the problems remaining, these types of analyses will insure changes in high latitude settlement against losses.

EDWARD J. TAAFFE AND BARRY J. GARNER—*The Peripheral Journey-to-work: A Simulation Approach*

This study deals with the emerging travel patterns associated with employment centers at the edges of American cities. In the future, these journey-to-work patterns should form an ever more important component of the total metropolitan traffic pattern since an increasingly large percentage of the total labor force will be employed in the peripheral zone.

Two sets of maps are analyzed. The first set presents a sequence of commuter patterns as one moves from Chicago's CBD to the edge of the city. The second set presents a group of simulated commuter patterns. That is, hy-

pothetical commuters have been distributed onto a gridded map according to the probability that each grid cell will originate a peripheral commuter. These simulation maps are then compared to the actual maps and the discrepancies between the two are analyzed.

The principal findings are: (1) The overwhelmingly dominant mode of transportation to peripheral work centers is the private auto. (2) At present, the majority of the peripheral labor force is concentrated around the peripheral employment center. (3) The factors affecting the dispersion of peripheral employees include: (a) population and distance ratios in a stepped or discontinuous rather than continuous fashion; (b) a tendency for more suburban commuters than city commuters; (c) a tendency for a disproportionate number of commuters to originate from a single radial sector; (d) the existence of alternate employment opportunities.

JOHN L. TAYLOR—*Making a Living in American Samoa*

Among the United States offshore flag areas in the Pacific is the 76-square-mile island area of American Samoa. With its 20,000 inhabitants, largely of Polynesian stock, American Samoa is attempting to improve its economic and social conditions against odds of considerable proportions.

American Samoa has been a possession of the United States since the turn of the present century; first under the administration of the Department of the Navy until 1951, and for the past decade under the Department of the Interior.

Except for about 20 percent of its area, the several islands comprising the Territory are too rugged to permit more than *milpa* and subsistence agriculture. Tuna fishing, copra, and handicraft production, government employment, and a budding tourist industry provide most of the income for the inhabitants. With the advent of regular air schedules and low, deferred transportation charges hundreds of younger Samoans are leaving for Hawaii and California. Thus the vigorous element in the population is being drawn off. The very high birth rate and a low death rate permits the population to increase, 46 percent from 1940 to 1950 and 5.8 percent from 1950 to 1960, but it is doubtful if this trend will continue unless means are found to improve economic conditions.

The United States Congress and the American Samoan Legislature are taking bold legislative steps to promote measures which will attract new capital and encourage new industries. The conservative Samoans, however, seem reticent to change their mores in order to imitate their mainland kinfolk or to adapt their lives to a monetary system like that pursued in the United States.

BENJAMIN E. THOMAS AND JOHN B. WHITTOW—*Climate and Economic Activity in the Somali Country*

In the Somali Country, seasonal changes in population and transportation, as well as basic occupations, are closely associated with climate. Except in the highlands, July temperatures average 80°F., and January temperatures, 70°F. The summer Southwest Monsoon causes drought because the air masses are warmed adiabatically on their descent from the higher plateaus of Ethiopia and Kenya. The winter Northwest Monsoon also brings little rain because the source regions are the cold high-pressure areas of Asia and the air masses cross the dry regions of Iran and Arabia. Interior Somalia has two periods of light rainfall, one after each equinox in the spring and fall, when the monsoons are not blowing.

Highland tribes migrate southward for the spring and fall grazing seasons. Northern coastal tribes move to higher elevations during the hot, dry summer. Farmers on the southern coast send their herds northward during the interior spring and fall rains.

Strong winds and rough water at Mogadishu impede use of the port during the monsoons. Many local roads are impassable during the rains, and the Wadi Shebeli is unnavigable during dry periods. Transport is scheduled to use the port, roads, and river at the appropriate seasons. Berbera has 40,000 inhabitants during the cool season when nomads, caravans, and Arab dhows visit the port, but only 20,000 during the torrid and inactive summer. Jibuti has a very hot, dry climate; the major local product is salt, obtained by evaporating moisture from basins of sea water.

MORGAN D. THOMAS—*Imports, Industrialization, and the Economic Growth and Development of Lesser Developed Countries*

There appears to be a growing interest on the part of many geographers in the problem of effecting economic development of the lesser developed parts of the world. The governments of these lesser developed countries, in general, are anxious to promote economic growth so as to provide the material means for raising the levels of consumption of their people. This paper is concerned with a short examination of one way of effecting industrialization, assuming the country chooses this means as the most desirable way of raising income per capita. Specifically, a brief study is made of the role of import substitution as a factor influencing industrial growth and as an economic development planning tool.

One may on *a priori* grounds suspect that import substitutions can contribute to economic growth and industrialization. The reasoning is along the following lines. In a growing economy there is a rise in effective demand. Given such conditions, "an increasing number of products, formerly imported, may be produced at home as soon as a sufficient volume of sales are reached by a plant of optimum size." Recent work cited supports the thesis that import substitution is a significant factor which influences the nature, direction, and rate of industrial growth.

Factors which condition the choice of industries that appear to have a good chance of being established successfully as producers of substitutes for selected imports are considered. In addition, it is shown that geographers have long studied various aspects of trade and industrialization. An attempt is made to outline briefly how their interest and some of their work on these topics can contribute to a greater understanding of the process of industrialization, and the achievement of a higher level of economic development in many parts of the world.

JOHN THOMPSON—*The Production and Marketing of Cattle in El Salvador, C. A.*

The production and trading of cattle are major phases of husbandry and of internal commerce in El Salvador. Herds of general purpose cattle are maintained by people who regard themselves as dairymen as much or more than as producers of meat. The herds are dependent upon natural cover and non-irrigated improved pasture. Seasonal drought, together with general malnutrition, disease and insect problems check productivity. In general former up-grading of cattle has been lost through dilution.

The main movement of cattle is toward west central El Salvador from land to the east and north of the Rio Lempa. Driving or rail shipping are employed. The flow, drawn largely from milking herds and the reservoir of working or breeding stock, is augmented by Honduran and Nicaraguan cattle. In assembling these market cattle, a weekly cycle is operative. Transactions are for cash at all stages except those involving the butchers who have beef dressed for urban distribution. Cattle are selected *al ojo*, by sight; and negotiations are direct, sometimes violently so.

Although each township operates a slaughterhouse, the individual wholesale butcher is responsible for the processing of his or her own stock. Women, absent from commerce until this wholesale butcher stage, dominate the retail trade of meat.

The whole chain of cattle and meat dealers is forged by tradition. Like the cattle raisers, who are landowners rather than husbandmen, they are shy of change. It is with difficulty that El Salvador will realize gains in the industry.

WALDO R. TOBLER—*Implications of Recent Innovation in Cartography*

Many of the rapid changes and improvements in cartography in the past few decades have implications for geographers. Research aimed at improving the legibility of maps can be traced back at least fifty years. Today satellite photographs provide new and different types of information. The accuracy of maps is also increasing. Here accuracy can be taken in the sense of the positioning of information on the map and in the sense of greater realism and relevance to human affairs. Statistical cartography on the other hand remains an area in which considerable improvement is needed.

Automated methods can increase the physical production of maps. More important, they force a re-examination of many of the conventional cartographic procedures. At-

tempts to prepare a population dot map using mechanical equipment, for example, suggest that enumeration districts and census tracts be replaced by a recording in terms of coordinates. The development of pattern-recognition techniques and map-reading equipment suggested intriguing but speculative questions about possible future innovations.

JOSEPH VELIKONJA — *The Italian-born in the United States, 1950*

The study of the numerical consistency and geographical distribution of Italian-born in the United States is based on the 1950 Census. The 1,427,145 Italian-born accounted for 0.94 percent of the nation's population and 14.1 percent of the foreign-born of which the Italians are the largest group.

The areal distribution based on state, county, and city figures indicates the areas of concentration on the Atlantic seaboard extending inland toward Chicago. California is a separate area. The relative importance of the Italian-born is worth considering, especially in the twelve states with proportions above the nation's average.

Over 90 percent of Italian-born live in cities. The New York urbanized area has over one-third of the nation's Italian-born. Nine other cities have 20 thousand or more, totaling 59.7 percent of all Italian-born. Sixty-eight other cities have over one thousand. The heaviest concentrations are found, as expected, in the largest metropolitan areas. These account for the high urban proportion of Italian-born in the states in which they are located. Eleven states have a higher urban proportion than the nation as a whole.

A detailed examination of the distribution shows that though the relative importance of the Italian-born in the total population seems to be insignificant for large areas and regions it assumes a considerable importance when examined in detail, especially for its urban clustering and the implications deriving from it.

The inventory type of descriptive analysis serves as a guide for further research on the contribution given by Italian as well as other national groups to the cultural and social pattern of the American nation.

STEPHEN S. VISHER—*The A.A.G. in its Early Years*

This paper presents statements as to the founding of the A.A.G., something of the distinction of many of the early members, and brief biographical sketches of as many of the more prominent early members as time permits. These sketches present information obtained from many sources including personal acquaintance. The speaker has attended 33 annual meetings commencing with that of 1907, and became acquainted with nearly all of the persons sketched. The members sketched were born before 1879; only one is still living; most of them were charter members or elected soon after 1904. Each of those contributed significantly to the advancement of some phase of geography.

WILLIAM H. WALLACE—*The "Bridge Line" in the Anglo-American Railnet*

Despite a recent wave of mergers, the Anglo-American railroad system remains unique in its operation by hundreds of separate companies. In the United States, and to a lesser degree in Canada, the large number of separate carriers makes it inaccurate to consider individual railways as discrete functional units. On all American and most Canadian railroads, traffic interchange with connecting lines constitutes a major part of all freight handled.

Although my major purpose here is to analyze the *bridge line*, the existence of other types of railways necessitates comment. In terms of freight traffic interchange with connecting lines, five major types of railroads may be recognized: *internal traffic railroads, originating railroads, bridge line railroads,* and *balanced traffic railroads.*

Bridge line railroads are railways whose leading class of tonnage is received from and delivered to connecting lines. The role of the *bridge line* may accurately be described as that of hauling freight to and from other systems. The forty major *bridge lines* of the United States and Canada are of many kinds, but it is possible to group nearly all of them into a few major classes on the basis of their functions. Along the United States–Canadian border are scattered the *International Transit Bridge Lines* and the *International Access Bridge Lines.* Elsewhere in the United States,

the following regional groups are found: *Vermont Bridge Lines, Middle Atlantic Bridge Lines, Midwestern Bridge Lines, Southern Bridge Lines, Southwestern Bridge Lines,* and *Western Bridge Lines.*

ROY I. WOLFE — *Transportation and Politics: the Example of Canada*

The interactions of transportation and politics have long been under study, but have often been the subject of too broad generalization on too few facts. Here study is restricted to a single country, Canada.

Canada's political life has been uniquely conditioned by transportation, but there is some danger in trying to derive generalizations from her experience. Most important is the greater-than-usual significance of her boundary with the United States, along whose 4,000-mile length the Canadian ecumene is thinly spread. The natural lines of communication run at right-angles to the unifying transportation routes, and difficulties are further increased by Canada's lack of a Middle West.

Nonetheless, a number of propositions arising from the Canadian experience may be tentatively presented, especially with respect to boundary questions. The disruptive effects on transportation of boundary instability is well demonstrated. The effect of the stable frontier of more recent days upon railways is shown to be both disruptive and attractive at the same time. Surprisingly, railways show the effect of the international boundary more sharply than do roads, whereas an internal boundary can have a much greater effect on a road system if cultural differences on either side of it are great enough.

The Seaway throws much light on the politics of canals, and the movement of water- and hydro-power gives rise to interesting political manipulations. Finally, the relation of local politics to local transportation offers a vast field of study in itself.

JAMES F. WOODRUFF—*A Study of the Characteristics of the Alabama Slave Population in 1850*

In a free society differences in composition and density of population generally manifest mobility in response to economic opportunity or personal aspirations. It is postulated that such differences in the slave population of the antebellum south, however, should reflect marked control by the owner group in response to agricultural economic conditions; that there should be a correlation between type and value of production, farm organization, and both quantity and quality of the slave labor force as measured by slave population composition.

This paper tests the validity of the thesis by examining the population characteristics of Alabama in 1850. The distribution and structure of the white population is compared with that of the slave population to establish that anomalies did exist. Difference in composition of the slave population from county to county, measured as variations in sex and age categories, are then analyzed and correlated to productive and farm organization criteria. It is established that there is a positive correlation between both percentage male and percentage 20–40 years old, and average size of farms and average value of farms. The relationship between percentage 0–10 years old is less significant and there is little relationship between percentage 50 years and older and the above parameters. Although correlations with more precise criteria of farm organization were not significant, they are good for type of production as expressed by cotton as a percentage of the total value produced.

The relationships thus established are synthesized into three maps which regionalize slave labor, farm organization, and agricultural productivity characteristics. From these maps it is possible to define four relatively distinct economic areas in Alabama in 1850.

BOGDAN ZABORSKI—*Smooth-flow Traffic Pattern and the Civil Defense*

The newly built planned city should be adapted to the requirements of modern heavy motor traffic and also to the needs of civil defense.

The combination of a set of west–east, one-way, arc-shaped avenues with connecting, snake-shaped streets (which mildly merge in them) will result in a road pattern on which "smooth-flow" traffic can function. Three additional north–south "arteries" with overpasses (or at another level) will also help in quick travel between the industrial districts (in N

and in S) and the business center, towards which all avenues are curved.

Roads will be restricted to moving traffic. For deliveries and visits to homes, side lanes will be used. Bus stops will be at "bays" where the pavement is suitably widened.

"Smooth-flow" traffic pattern would enable quick and efficient evacuation of the city if this course is decided upon in view of warning of an expected nuclear attack. The whole road network will serve then as one-way communication lines leading out of the center of the city. The distance of the reception area will depend on the length of warning period. If this is 15 minutes—the cars will have time to go 6 miles; if 30 minutes—they will go 15 miles. Both ways, from 4 to 20 miles at least, earthen or rock escarpments, facing away from the expected blast direction, will be built to give primitive shelter, even though more complete and expensive measures cannot be taken.

WILBUR ZELINSKY — *Geographic Patterns of Change in the Rural Population of the United States, 1790–1960*

Changes in the rural population of each United States county from its first Census enumeration through 1960 have been analyzed with the immediate aim of detecting such temporal and geographical configurations as may exist and the ultimate purpose of relating these to other geographical and historical patterns, thus enriching our insight into our total geography. Four serious technical problems confronted and only partially solved in this study necessitate rather qualified acceptance of the results: the arbitrary unrealistic official definition of rural population; the major revision of this definition in 1950; numerous changes in county boundaries; and the absence of any meaningful, consistent subdivision of aggregate rural population into its disparate components. Nevertheless, preliminary analysis of the statistics reveals major, geographically significant differences in the dates when counties attained their maximum rural populations, with progressively later dates moving outward from the national socioeconomic core aligned along an axis reaching from southern New England to eastern Iowa. Five distinct temporal phases were found in the rural "life cycle" of the county. The great majority have achieved the third stage, with the fourth and fifth limited to the most economically advanced. There were also five major types of rural population change noted in examining the time series. Despite some ambiguity in the locational significance of these types and a few striking anomalies, they do seem to relate to some major geographic and socioeconomic factors. It is hoped that more detailed statistical and cartographic analysis will elucidate the nature of these interrelations.